SCIENTIFIC AMERICAN SUPPLEMENT. No. 1221

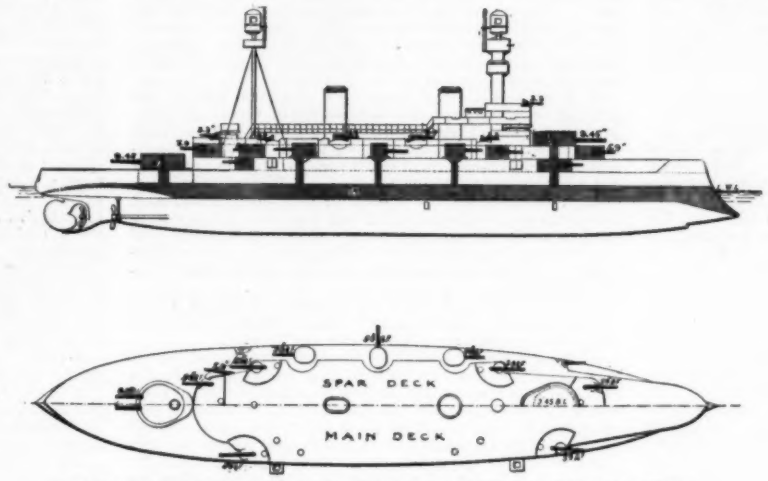
Copyright, 1899, by Munn & Co.

Scientific American, established 1845.
Scientific American Supplement. Vol. XLVII. No. 1221. NEW YORK, MAY 27, 1899. Scientific American Supplement. $5 a year.
Scientific American and Supplement. $7 a year.

THE NEW GERMAN FIRST-CLASS BATTLESHIP "KAISER FRIEDRICH III."

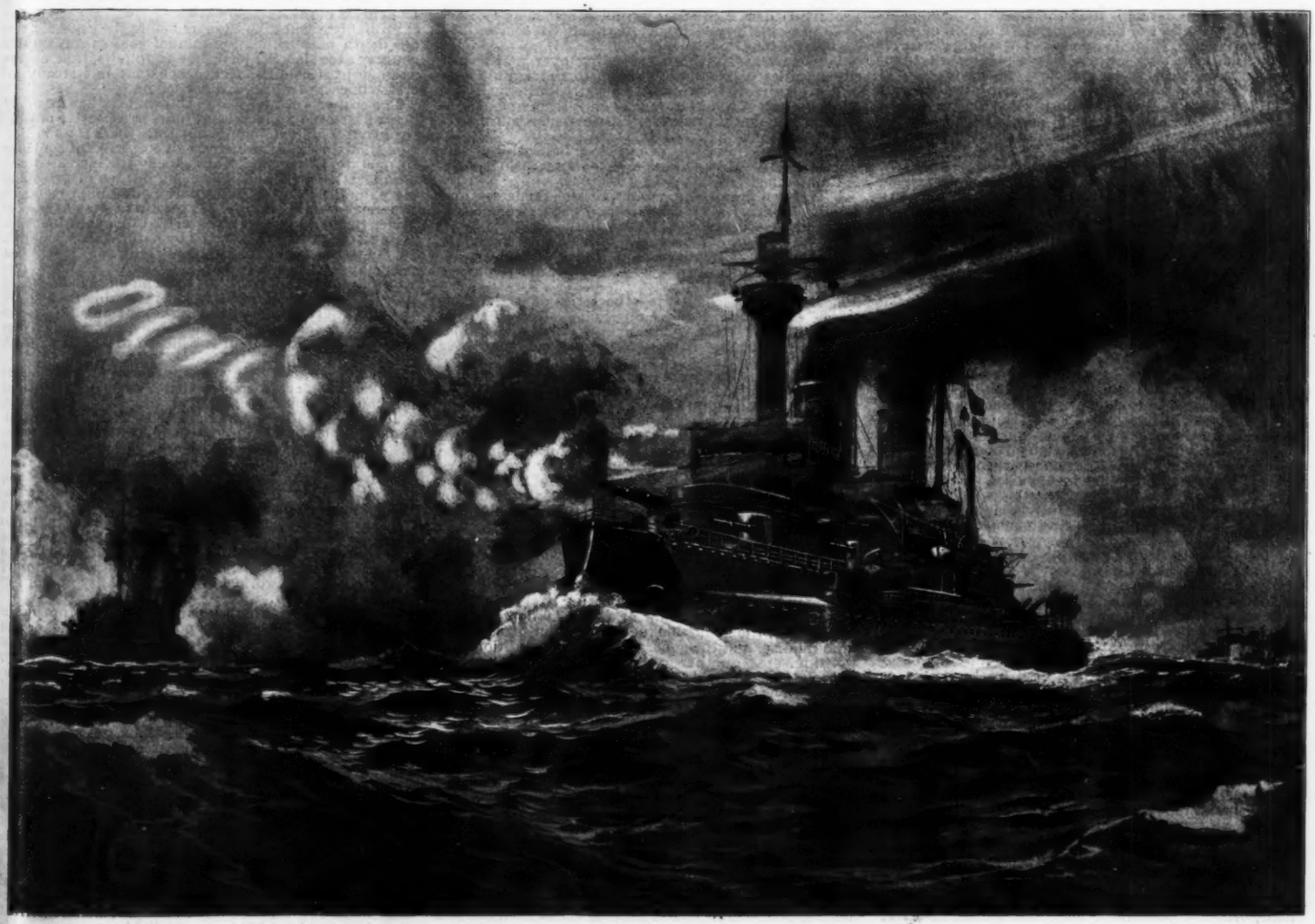
We present a very realistic illustration of the latest type of battleship designed and built for the German navy. The vessel shown is one of a class of four ships, three of which, the "Kaiser Friedrich III.," the "Kaiser Wilhelm II.," and the "Ersatz König Wilhelm," have been launched, and are now receiving their finishing touches before undergoing the government trial, while two others have been commenced. They are of special interest as representing the latest ideas of the German naval architects as to what constitutes the best combination of fighting qualities in a first-class modern warship. It is only of late years that the Germans have thrown themselves into the work of naval construction with an earnestness and on a scale commensurate with their wealth and vast resources, and it must be confessed that in their latest ships, as shown in this year's programme of construction, they are fully abreast of the foremost naval designers of the world.

The effective list of the German navy includes the name of only one ship, the "König Wilhelm," that was launched prior to the Franco German war. The present German navy has grown up entirely under the Emperors, and to none of them is its standing due so much as to the present Emperor, William II. At the outbreak of the war of 1870 there were but five ironclads opposed to the formidable French navy, one of which, the "König Wilhelm," still survives, and, indeed, has only recently been reconstructed and armed with a powerful battery of modern rapid-fire guns. During the decade 1870–1880, there were added to the German navy four battleships, carrying a central citadel and a continuous belt, and the four partially belted battleships of the "Saxon" class, vessels of between seven and eight thousand tons displacement and fourteen knots speed. There were also constructed eleven small coast defense vessels of about 1,100 tons displacement and 10 knots speed, each carrying a 12-inch gun in the bow. In the following decade, 1880–1890, things were at a very low ebb in the German navy, the upbuilding of her magnificent army monopolizing the attention of the government. Only one small battleship and a few gunboats and cruisers being added to the navy. The most important of the cruisers were the protected vessels "Irene" and "Prinzess Wilhelm," of 4,400 tons, and 19·8 and 18·7 knots speed respectively, launched in 1887. With the advent of the present Emperor to the throne, a brighter era dawned on the German navy; for the young Kaiser, who, like his brother Henry, is a thorough sailor at heart, at once set himself with his characteristic energy and perseverance to the task of awakening the German people to a sense of the importance of their maritime interests and the necessity for a navy adequate to their protection. For the first few years of his reign he was confronted either by stolid indifference or active and bitter opposition; but of late years he has succeeded in carrying through his policy with very flattering and encouraging success. In the early part of his reign four powerful and effective battleships known as the "Brandenburg" class were added to the navy, and eight vessels of the "Siegfried" type were built for the defense of the coast, while of late years the cruiser classes have been enlarged by the construction of the "Kaiserin Augusta," "Gefion," and the very excellent ships of the "Hertha" type.



"KAISER FRIEDRICH III."—CLASS OF FOUR BATTLESHIPS.

It was last year, however, that the German Emperor scored his most decisive triumph in the passing of what is known as the Naval Septennate programme, which is so named because it is patterned after the system adopted for the army. It provides for what is actually the construction of a completely new navy, the work upon and cost



THE NEW GERMAN FIRST-CLASS BATTLESHIP "KAISER FRIEDRICH III."

Displacement, 11,130 tons. Speed, 18 knots. Normal coal supply, 650 tons. Armor: Belt, 11¾ inches; gun positions, 9¾ to 6 inches; deck, 3 inches. Armament, four 9·4-inch rapid-firers, eighteen 5·9-inch rapid-firers, twelve 3·5-inch rapid-firers, eight machine guns. Torpedo tubes, 6 (5 submerged). Complement, 655. Date, 1896.

of which is to extend over a period of seven years. According to the bill, the strength of the navy is to be raised to 17 battleships, 8 coast defense vessels, 9 large cruisers, and 26 smaller cruisers. This will necessitate the construction of 7 new battleships, 2 large and 7 small cruisers, and a large number of gunboats and torpedo boats, which must be built from time to time to replace worn-out vessels which will be removed from the active list. The total cost contemplated by the Septennate bill is $103,000,000, and all of the ships are to be commissioned by the close of the year 1904.

At the commencement of the present year, as will be seen by reference to the comparative estimate of the various navies of the world, published in the SCIENTIFIC AMERICAN of December 31, 1898, the strength of the German navy, including all vessels actually commenced in the yards, was as follows: 19 battleships, 1 armored cruiser, 12 protected cruisers, of between 2,000 and 7,000 tons displacement, and 22 small cruisers and gunboats—a total of 73 vessels and an aggregate displacement of 299,637 tons.

At present the strength of the United States navy, reckoned by displacement, is a few thousand tons greater than that of Germany, and, as our present rate of construction is greater, it is probable we shall increase our lead over that navy steadily as the years pass by.

The most important ships of the new programme are, of course, the battleships of the "Kaiser Friedrich III." class. They are to be compared with such vessels as the "Maine," of our own navy, the British "Magnificent," the French "Charlemagne," the Italian "Re Umberto," and the Japanese "Fugi."

The displacement of 11,130 tons is very moderate, judged by contemporary practice, being about equal to that of the "Charlemagne," 1,000 tons less than that of the "Fugi," 1,400 tons less than the "Maine," 2,700 tons less than the "Re Umberto," while the "Majestic" exceeds it by 3,700 tons. In comparison with her displacement, her armament is unusually powerful.

The Germans were among the first to give up the construction of the abnormally heavy gun and turn to weapons of more convenient dimensions. Thus, in the ships of the "Brandenburg" type, they were content to use an 11-inch gun for the main armament at a time when other nations were using 13 and 13½-inch guns for this purpose. In the latest battleships they have still further reduced the dimensions and weight of the heavy guns, for the "Kaiser Friedrich III." does not carry a larger caliber than 9·5 inches, four guns of this size, placed within 9¾-inch turrets, two forward and two aft, constituting the main battery. The moderate dimensions, however, are more than compensated for by the fact that the guns are of the rapid-fire type, and deliver a 474-pound projectile with a muzzle energy of 17,340 foot-tons and a penetration of 23½ inches of steel. In the secondary battery there are thirty rapid-fire guns of the larger sizes, namely, eighteen 5·9-inch rapid-fire guns, each in a separate turret or casemate, and twelve 3·3-inch rapid-firers, protected by revolving shields. The ship also carries some twenty or so 1-pounders and machine guns, which are distributed in advantageous positions throughout the bridges and military tops.

Our readers will observe, on studying the engraving and diagram of the ship, that the Germans have paid particular attention to the important question of wide distribution of the guns. In view of the large area of destruction of a bursting shell, it is evident that the various guns with their gun detachments or crews should be as widely scattered throughout the ship as possible, with a view to limiting the destructive action of any one shell. It seems to us that the German naval architects have worked out this problem with excellent results. It will be seen that the larger rapid-fire guns are not only carried at four different stages of elevation above the water, but they are widely separated from each other on each deck. The lowest guns are the two 9·4-inch rapid-firers on the after turret on the main deck and the four 5·9-inch which are carried in casemates, two forward and two aft on the same deck. On the spar deck, above, are six 5·9-inch in turrets on the broadside and eight 5·9-inch guns in casemates, the latter being placed four forward and four aft. Forward in a turret on the superstructure deck, and thirty feet above the water, is the remaining pair of the 9·4-inch rapid-fire rifles, and ten 3·3-inch rapid-firers are carried at the same height, some in broadside, and others astern on the same deck, while yet another pair of 3·3-inch guns is mounted on the upper bridge at a height of 46 feet above the water line. The concentration of fire is tremendous, consisting of two 9·4-inch, eight 5·9-inch and six 3·3-inch ahead; four 9·4-inch, nine 5·9-inch, and six 3·3-inch on either beam; and two 9·4-inch, eight 5·9-inch and four 3·3-inch astern. The belt armor varies in thickness from 11¾ inches amidships to 6 inches at the ends; while the armor on the main turrets is 9¾ inches in thickness, and on the smaller turrets and casemates 6 inches. The boiler plant will be made up of a combination of cylindrical and Thornycroft boilers, while the vessel will be driven by triple screws at a speed of eighteen knots per hour.

Of course, where so much displacement has been allotted to the batteries and necessarily large ammunition supply for rapid-fire guns, we must expect that some other elements in the ship have been sacrificed. We could wish, for instance, that the side armor had been carried up to the main deck, and that the bases of the main turrets were protected by barbettes, as is the practice in our own and in the British navies, and we think that in a stand-up fight between the "Maine" and the "Brandenburg," the latter would be at a great disadvantage in this respect. Nevertheless, we must confess to considerable admiration for these magnificent fighting ships. They have a tremendous rapid-fire battery, an unusual end-on fire, a wide separation of the guns, and a great command, features which should render these ships very effective fighting machines if properly handled.

Ground oyster shells were given by the medieval doctors to children suffering from rickets and scrofula. Now it appears that they were right. The shells contain lime, nitrogen, iron, sulphur, manganese, magnesia, flour, bromide, phosphoric acid, and iodine, all excellent for feeble children. They say that if growing children were to take powdered oyster shells in their food, the teeth would be improved.

BRITISH COAL SUPPLIES.*

By T. FORSTER BROWN.

THE writer's apology for bringing this subject before the Society of Arts is his desire to enlist the assistance of its members in inducing politicians and the public generally to consider and deal with the material and important problems which underlie the coal question, with the primary object of providing, if practicable, a remedy for, or counterpoise to the effect of, the future increasing cost of our supplies of fuel.

This future increased cost of coal, reacting upon the whole of our manufacturing industries, will undoubtedly land the nation in serious financial and political difficulties, if remedial measures are not adopted, and these measures, to be of value, should be inaugurated during the period when the possession of good and cheap fuel enables the nation to maintain its commercial prosperity.

I will not attempt to dwell upon the origin and nature of coal, but proceed at once to the main problems I desire to direct attention to, and, shortly stated, they are:

1. That while we have in Great Britain large unworked coal resources, sufficient probably to maintain a rate of working exceeding our present annual output for 300 years, or thereabout, we are now rapidly exhausting the cream and cheapest of these resources; and in 50 years or thereabout the greater part of the most valuable of our coal supplies will have been exhausted, except only such as can be worked at a greatly increased cost, which cost, after half a century, will rapidly increase.

2. That the United States of America possess far more extensive coal fields than those of Great Britain, and that country already produces coal at a somewhat cheaper cost than we do, and so far as physical conditions affect the cost, will continue to produce cheaply for a far longer period than we can. With the exhaustion, therefore, of the cream of our coal fields, and when we shall have nothing left but our more costly coal to work, the American competition will become of far more serious import to this country in all our commercial relations than it is likely to be in the immediate future.

3. The large coal fields of Russia and China, when further developed, will also become serious additional factors in competition with us in the future.

Upon the first question of the coal supplies of Great Britain, I cannot do better than follow Prof. Hull's (than whom I know no better authority) careful estimate of the approximate quantity of workable coal which will remain unworked at the end of the present century down to a depth of 4,000 feet below the surface, which is the probable utmost limit of depth at which it will be practicable to work coal. The resources exist in six large coal fields and a small quantity in Ireland, plus some small addition due to an extension of the coal measures between Dover and Bath.

These coal fields and their estimated resources in seams of two feet and upward in thickness down to a depth of 4,000 feet, as given by Prof. Hull, are as follows:

1. The Midlands, extending into the counties of York, Derby, Nottingham, Stafford, Leicester, and Warwick. From this district, house, manufacturing, and steam coals are chiefly produced. Estimated resources, 35,000,000,000 tons.

2. The Great Northern, extending over portions of the counties of Northumberland, Durham, and Cumberland, chiefly the two first named counties. House and gas coals of the best quality and steam and manufacturing coals are produced. Estimated resources, 6,000,000,000 tons.

3. The Northwestern, comprising Lancashire, East Cheshire, etc. House, gas, and manufacturing coals. Estimated resources, 11,000,000,000 tons.

4. Western group, comprising Bristol, Somerset, and Forest of Dean. House and second class steam coals. Estimated resources, 2,000,000,000 tons.

5. The Welsh, comprising South Wales, including Monmouthshire, Denbigh, and Flint. Steam, house, gas, and manufacturing coals. Estimated resources, 20,000,000,000 tons.

6. The Scotch, comprising the series of coal basins which extend across Scotland from Ardrossan to the Firth of Forth. Gas, steam, manufacturing, smelting, and smith's coals. Estimated resources, 8,000,000,000 tons.

The Irish coal fields are estimated to contain of visible and concealed coal to the extent of some 155,000,000 tons, making the total available coal resources in the year 1900 about 82,000,000,000 tons.

The conditions which regulate the value of the coal resources of all coal fields are many and various: the thickness of the seams, their depth below the surface, the friability or otherwise of the roofs and floors of the seams, the inclination of the seams of coal, the dry or watery nature of the strata associated with the coal beds; and the coal itself, its friability, the proportion it contains of carbon and hydrogen and other volatile matter and its comparative freedom from indestructible ash and sulphur.

It follows that while one coal field or part of a coal field may be extremely valuable, owing to the measures lying nearly horizontal and at no great depth below the surface, the great thickness of certain seams, their high quality, and the general favorable conditions for working, etc., another coal field, or another portion of the same coal field, may be of little value, owing to the seams existing at great depths, involving heavy pumping, being thin, lying at steep gradients, containing too much or too little volatile matter, or too much dirt and refuse in the form of ash and sulphur, making it impossible to work such inferior seams of coal in competition with the best coals.

More clearly defined, the most valuable part of any existing coal field in this or other countries comprises seams of upward of three feet in thickness of coal, containing from 12 to 30 per cent. of volatile matter, and in the case of certain anthracite down to 6 per cent., and leaving a residuum after burning of from 2 to 5 per cent. of ash and from 0·50 to 1 per cent. of sulphur, which seams are deposited upon an easy inclination and with good roofs and floors. While the less valuable seams of coal fields contain coal seams from two feet and upward in thickness, containing from 5 to 12 per cent. of volatile matter, and again from 30 to 40 per cent. of volatile matter, also thick seams of best quality existing at great depths, steep inclinations, and so on, so that practically, while certain coal fields of the world produce coal of exceptional quality, such as the steam coal of South Wales, the gas and bituminous coals of Durham and the Midlands, the furnace coal of Scotland, the cannel coal of Lancashire, the anthracite and semi-anthracite coals of Pennsylvania and the Pittsburg region of the United States, and the coal of the Westport coal field of New Zealand, which last named is a deposit of Cretaceo-Tertiary age, nearly every coal field contains a considerable proportion of comparatively inferior deposits, and many coal fields, more particularly those which are of a more modern geological age than the Carboniferous period, do not contain any of the most valuable coal deposits. Therefore, in taking the measure of the extent and resources of our coal supplies, it becomes of importance that we should have all the circumstances in our minds before attempting to generalize as to the real value and extent of our coal resources, what proportions are good and cheaply worked and what proportions are of less value, and under existing conditions not capable of maintaining such a supply of cheap and high class fuel as will enable our industries and manufactures to compete successfully with the products of countries which possess better fuels which are worked at a cheaper cost.

Taking all the circumstances into consideration, the author of this paper estimates that of the best and cheapest of the coal supplies of Great Britain there originally existed about 20,000,000,000 tons, existing at a less depth than 2,000 feet below the surface, and that there may be probably still remaining at the end of 1899 about 15,000,000,000 tons of this quantity, the bulk of which he estimates will be exhausted by the middle of the next century, leaving about 67,000,000,000 tons of coal still available, sufficient to supply 250,000,000 tons a year output for upward of 250 years, but comprising coal either of inferior quality or best coal obtainable at a greater cost per ton than at present prevails, owing to physical disadvantages by reason of depth, etc.

The present depths at which our coal mining operations are carried on are comparatively shallow. There are some few collieries working at depths between 2,000 to 2,500 feet, but the average depth below the surface from which our existing coal supplies are obtained will not exceed probably from 750 to 850 feet; this average depth will increase gradually, and it is apparent that when the average depth exceeds 1,000 feet, and still more when the average exceeds 2,000 feet, and so on, the causes which enhance the cost of working due to extra depth will come more and more into operation.

Up to the present, the altered conditions due to higher temperatures, and increased cost of working due to depth and temperature, have naturally not made themselves apparent. Four thousand feet has generally been considered the ultimate limit in depth for all coal working. It is doubtful even if this limit can be attained, but if it is, it will be only at a very high cost of working, probably more than double the cost of working which now prevails, owing to the reduction in the useful effect of labor in high temperatures and the large consumption of power in raising from great depths.

Probably it will take 50 years before the general average depth of working the annual coal supply of this country exceeds 1,500 feet; but it follows that as the average exceeds 1,500 feet, a constant but steady increase in cost of working must set in.

The cost of working coal in this country has for many years past been an increasing one, irrespective of physical causes, and at the present time there is no indication that this gradual increase of cost will not continue to operate. The causes are chiefly the increased cost of labor, the extra and increasing burden of rates and taxes, and the larger colliery staffs and improvements necessary to meet the various requirements of the Coal Mines Regulations and Workmen's Compensation Acts.

But so far as cost is affected by natural causes, depth, thickness of seam, and quality, I think that it will be a reasonable supposition that a moderate cost will prevail for another 50 years, at the end of which period physical causes will begin to operate which will have the effect of steadily increasing the cost until it reaches such a figure as to render profitable mining operations impossible, and this limit is believed to be about 4,000 feet below the surface.

It may be argued that with our increasing cost means will be provided to reduce that cost with improved mechanical appliances, etc. This alternative, however, will not bear investigation, for, as time goes on, although undoubtedly improvements will take place in mechanical appliances, in the application of labor for "getting" thin seams, in hauling, and in the manipulation of the coal when it arrives at the surface, these improvements will equally apply to the operations of our competitors in other countries, and will still leave unsolved the comparative increase of cost due to great depth and high temperature and increased cost in the working of thin seams in competition with the working of thick seams, and to a certain proportion of coal having to be worked of inferior quality and of less evaporative power.

At present the greater part of our coal output is being worked from collieries possessing the thicker and more valuable seams lying at comparatively shallow depths below the surface; and we shall certainly, within the next 50 years, see an appreciable diminution of output, owing to approaching exhaustion of these collieries, and there remains at present comparatively few unlet mineral tracts in this country, except where the coal lies at a great depth.

Of course, the duration of what at present remains of the cheaper and best coal seams depends upon the rate of output, but the period of exhaustion must sooner or later arise.

Summarizing our coal resources, we have—in seams of 2 feet and upward in thickness, within a depth of 4,000 feet below the surface—an estimated available quantity of coal (visible and concealed), including the Irish coal fields, of 82,000,000,000 tons.

Now, it may be well to inquire how far is this total of 82,000,000,000 tons, which is sufficient, at our existing rate of output, to supply the requirements of Great Britain for at least 300 years, available at a reasonable cost?

To begin with, from the commencement of the pre-

* Paper read before the Society of Arts, London, April 19, 1899.

sent century, and previously, coal has been worked, and at an increasingly rapid rate during the last 25 years, from the thickest seams of best quality existing near the outcrop and down to a moderate depth below the surface, and the quantity already worked exceeds 5,000,000,000 tons. The good coal near the outcrops has been already practically exhausted, and deep pits in later years have been necessary to win some of the best seams.

Anyone who is practically acquainted with coal mining is aware that with this increasing depth there is a distinct increase in the cost of working, and if all our coal at the present day was produced from a depth of 2,000 feet, it would be much more costly than is our average present cost of working.

Once a depth of 2,000 feet or thereabout is reached, the effects of the increase in temperature and pressure due to depth begin to operate, in addition to the cost of the increased power required, and of course increased depth means greater capital outlay, and the interest upon this increase of capital also becomes a fresh charge upon the mineral produced.

Fifty years ago the average depth from which our coal supply was obtained was probably less than 300 feet below the surface. To-day the average depth from which the whole of our annual supply is obtained may be taken to be about 800 feet, and 50 years hence the average may have increased probably to 1,500 or 1,800 feet, the larger annual output rendering the process of exhaustion, as regards depth, more rapid in the future than it has been in the past.

The increasing cost due to the greater depths of winnings, so far as it is merely a question of more expenditure of power, has been and will be met partly by improved mechanical appliances as previously mentioned, increased outputs and so forth, but when the temperature becomes so high as to reduce the useful results of manual labor and horse power, then we have a new element introduced which inevitably increases the cost.

The writer's experience in colliery operations, carried on at depths exceeding 2,000 feet, fully bears this out, and although it may be practicable to modify the conditions, even in regard to temperature, in some degree, a serious gradual increase of cost due to the increased depth, etc., is inevitable. And already, notwithstanding the various improvements which have been effected in mining operations during the last half a century, the average cost of raising coal to-day, irrespective of fluctuations in wages, is probably 15 per cent. above what it was 50 years ago.

The fact that within the last 25 years a great number of collieries have been opened upon large areas of coalfield, and that it will require 30 to 60 years to exhaust the resources of these modern collieries, indicates approximately the period when the cost will rapidly advance. It will only be upon the exhaustion of the bulk of the best coal available to already existing collieries, and the future output having to be maintained by recourse to deeper winnings, that an important step in the direction of increased cost due to depth will begin to operate. Therefore, whatever remedial measures are adopted, they ought to be so arranged as to come into partial operation by the end of half a century, and be capable of adjustment so far as they can be utilized from decade to decade to counteract the effect of the increasing cost of working these remaining portions of our coal supplies.

It may be of interest here to state that a reasonable estimate of the horse power produced by such portion of our annual output of coal as is utilized for industrial purposes is about 25,000,000 horses, and the approximate present cost at the points of consumption at between 25s. and 35s. per horse power per annum; while if all our exports of coal and coal used for gas and household purposes were included, it would represent 50,000,000 horse power per annum, equal, if it were practicable for man to perform the same labor, but it is not, to the work of a population of 500,000,000 working people who would have to be supported.

I may refer, before approaching the question of the American coal-fields, to Mulhall's estimated areas of coal lands in various countries, which he gives as follows:

	Square miles.
Great Britain	9,000
United States of America	194,000
Russia	27,000
China and Japan	200,000
Germany	3,600
Belgium and Spain	1,400
India	35,000
France	1,800

To which might be added enormous areas of lignite in various parts of the world. The coal-fields which have just been enumerated are chiefly of the Carboniferous period.

Our colonies of North America, Australia, New Zealand, and South Africa are not given.

Assuming the coal acreage of America, China, and Russia to contain a fair proportion of workable coal, it will be apparent how far in excess of our resources are those of these three countries, and that consequently how much larger is the extent of coal accessible in these countries, either without pumping, or at very shallow depth below the surface, and therefore at a cheap cost, compared with Great Britain.

2. With regard to the second head, that the United States possess more extensive coal-fields than Great Britain, and that their competition in the future will become serious in our foreign markets, including the markets of the United States.

America produces coal of all qualities, and the coal-fields extend over an enormous district of country provided with excellent railway accommodation; the rivers also afford unusual facilities for the internal cheap conveyance of the minerals. The great drawback of the American coal-fields, and our chief safeguard in regard to their competition with us in foreign markets, is the great distance at which the important American coal-fields lie from the Atlantic sea-board.

Nevertheless, America has made rapid strides in the direction of competition with this country—(1) By the cheap construction of the railways, and (2) by the exceptionally low rates per ton per mile charged for the carriage of minerals. These rates are something like one-fourth of the current rate per ton per mile charged for similar traffic in this country. At present, coal from the neighborhood of Pittsburg is delivered on the Atlantic sea-board at a lower rate per ton than coal of a similar quality is sold F.O.B. in this country, yet the distance from Pittsburg to the sea-board is about 300 miles, I believe, and the cost of carriage of coal, I am advised, does not exceed one dollar per ton.

The American anthracite coal of great purity is widely and successfully used for commercial purposes, and the carbonaceous steam coals are of a high class quality, but so far as the writer is informed, are not so hard and do not bear carriage so well as the best Welsh steam coal. Notwithstanding, however, our low cost of working and cheap sea transit of late years, we are beginning to feel the pressure in our distant markets of the American competition. This competition will not become less severe probably in the immediate future, but if the time arrives that British coal becomes more permanently costly F.O.B., the American competition will assume serious proportions.

3. Upon the third point of the competition of the Russian and Chinese coal fields.

Russia possesses coal-fields of at least three times the area of those of Great Britain, and is now beginning to develop her coal resources in the south near the Black Sea. The present supplies are applied chiefly to home consumption for household and manufacturing purposes. The Russian coal is of various qualities, and ranges from anthracite to highly bituminous. It is produced at the present day in some districts in the writer's knowledge at a lower cost per ton than is the average cost of working in this country.

The distance of the Russian coal-fields from her sea-boards is greater than in Great Britain, and we have thus, as in the case of America, more or less of a safeguard, so far as competition with us in foreign markets is concerned, but the much greater coal-fields of China are now on the point of being more or less extensively developed. The extent is variously estimated, but it is probable that the Chinese coal-fields extend over a surface area equal in area to the American coal-fields, and there are reasons for believing that in the neighborhood of the Gulf of Pe-chi-li collieries will come into working operation within a short period. This part of the Chinese field is believed to contain coals of good quality for navigation and manufacturing purposes, and is comparatively near the sea-board. The large coal-fields of Central China may not be developed so rapidly, but it may be noted that although distant from the sea-board, yet the facilities for transit afforded by the large navigable rivers and cheap labor reduce the effect of this distance immensely, and the carriage from these inland coal-fields will probably represent a moderate cost. Besides, for internal consumption, provided the coal is good and worked cheaply, the distance to the sea-board is not so important.

The cheap labor available in China, and the shallow depths from which their coal will be worked, indicate that the Chinese coal will be delivered at the sea-board at such a low cost as will enable that country to compete with all other countries for the trade of the Eastern hemisphere. We have, therefore, undoubtedly to anticipate very keen competition in the future, so far as our markets in that region are concerned, for many descriptions of manufactured goods and for coaling the mercantile marine which frequent the Eastern seas.

The conditions prevailing in these principal foreign coal fields are, therefore, in the direction of cheapening the production of coal; while in this country the tendency of the conditions is to increase the cost of working coal, and unless we can ultimately do something material to check this increase of cost, a time will arrive—the author thinks in half a century at the latest—when as a nation we shall have to face the probability of our manufacturing position being rapidly effaced in consequence of the dearness in cost of the fuel we have to employ in our various manufacturing processes, and in the supplying of our mercantile marine as compared with the cheapness of the coal used by our competitors.

Then, with regard to Germany and Belgium. These two countries are our chief manufacturing competitors in Europe. The German coal fields are less in extent than our own, and the average qualities of their coals are possibly somewhat inferior compared with the best of our coals, yet Germany, by reducing the cost of carriage on her State railways to less than half the rate per ton per mile charged in this country, has been able to develop a large and increasing home and foreign coal trade from her principal coal fields in Westphalia. As time goes on, however, difficulties will arise in Germany as well as in Belgium from increasing depths, and they will be of the same character as those we shall have to contend with in Great Britain. Germany and Belgium will, however, be probably in a worse position than we are, because they have already reduced their rates of carriage to a minimum, or thereabout.

To Germany and Belgium the industrial competition of America and China will therefore be of the most serious import. Germany, however, is not as dependent on her coal for her maintenance and prosperity as we are on ours. The area of Germany is large, and her soil is more productive, and will feed a much larger population than the soil of Great Britain can support. Reviewing the whole question, this country is exceedingly well placed with regard to the distribution of her coal fields, situated as they are generally near the sea-board, and possess coals of exceptional quality; so long, therefore, as our high-class fuels are producible at a moderate cost, we shall, provided we retain our maritime supremacy, in all probability remain in a flourishing commercial position, so far, at any rate, as physical conditions affect the question of the cost of producing coal. In regard, however, to our internal means of communication, although a very comprehensive system of railways has been established for the accommodation of the enormous traffic of this country, the rates charged for transit as compared with those current in America, Germany and Belgium, especially for minerals, are exceptionally high, about four times the American rate per ton per mile, and twice the rates charged by Germany and Belgium. But notwithstanding this fact, by reason of our nearness to our home markets and to the sea-board, so long as our best coal remains unexhausted, at a moderate depth and cost, we shall probably be able to hold our position in the markets of the world with our manufactures.

But as the writer has suggested, in half a century from the present time conditions will become unfavorable for the production of cheap coal, and the problem he wishes to discuss is the nature of the remedial measures, if any, which it may be practicable to adopt to enable that half century of probable prosperity being extended to two to three centuries.

If from the national point of view it was considered essential that the nation should possess all the turnpike roads in the country, how much more is it necessary that the nation should possess the railways, which are the far more important means of internal communication? Unfortunately, no provision was made for the State building of the railways, although power was obtained in 1844 by means of which they can be purchased by the State, I believe, at any time. The railways have been constructed by private enterprise at an enormous cost, due to various causes; the annual net revenue, however, under existing conditions is something like £40,000,000 per annum, and in 30 to 40 years the net income will probably have increased to at least £50,000,000 per annum.

To this should be added the enormous loss by reason of the present system of management, the unsuitability of the rolling stock for economical working, and unnecessary competition involving the running of trains with inadequate loads, etc. Probably, the income of the railways of Great Britain, if they were in one hand, and the management organized on different lines, would represent an annual net revenue in 30 to 40 years time of £60,000,000.

Now, if this fund of £60,000,000 per annum or such part of it as becomes necessary were available to be drawn upon; that is to say, if the railway rates for all classes of minerals, goods and passengers were reduced decade by decade to counteract the general effect of the increased cost of producing the minerals, we should be able to utilize the whole of our existing coal resources under practically as favorable conditions as we shall utilize the best and cheapest of our coal resources during the next fifty years.

FUTURE OF COAL.

It may be contended that at some period in the future a successful substitute for coal may be discovered, but we must bear in mind the extreme cheapness of coal and the possibility of so economizing its consumption that 2¼ pounds of coal per hour will produce one horse power on the average, equal if coal is valued at 7s. per per ton to one horse power for 10 hours per day for 1d. It does not, therefore, appear probable that a substitute of equal power is likely to be discovered at anything approaching such a cost, and what will happen as coal becomes dearer in this country will be a gradual transference of the manufacturing operations which supply the world to countries where the cheapest coal is produced.

It further follows that so long as cheap coal can be worked in this country, the demand for it will continue to increase until at all events all the moderately deep coal areas available in Great Britain are occupied, and it may, it is suggested, be assumed that before the whole of those areas are occupied the output of coal, now slightly over 200,000,000 tons per annum, will be increased to 250,000,000 tons per annum.

And now as to the vexed question of our expensive means of internal communication in this country. It would appear that if during the next half century the nation is spared international difficulties, such as a great war, we may expect to enjoy a most prosperous period in our manufacturing industries, owing to the large supply of cheap and good coal. With markets in our widely spread colonial empire, our position will remain unique, and if during that period something can be done to counteract fully, or even partially, the increasing cost of producing coal which will inevitably subsequently arrive, then the nation will be in a condition to maintain its existing commercial prosperity, so far as cheap coal is concerned, for centuries. But having regard to the long period during which this prosperity may be expected to prevail, and the economical conditions under which the nation may exist, other favorable conditions may be created such as that of becoming the home of the finer industries, involving the employment of much labor and less fuel. This country may also become populous as a residential country, and, as it is the center of a great empire, cheap coal supplies may in the far distant future become less of an urgent necessity.

The direction in which relief is to be found is the cheapening of our internal communications, and the reduction of our rates and taxes. Now the only mode of doing this appears to the author to be the repayment during the next half century or thereabout of the whole of the capital outlay of this country in railways, docks, sanitation, water, and other public workings.

It is obvious that the nation, in paying off the National Debt at a substantial rate, is providing in some degree for the relief of future generations, but while the repayment of this debt is of undoubted importance from the point of view of relief to our successors, and in providing a fund from which we can obtain loans for carrying on warfare, it may be observed that the permanent relief to the nation by paying off the whole of this debt will be about £25,000,000 per annum, an annual amount which has been swallowed up during the last few years in increased annual national expenditure. Assuming that by means of the repayment of the National Debt the annual expenditure to maintain our Army, Navy, and Civil Services, and Education, is reduced to under £100,000,000, how can even this enormous revenue be obtained if our commercial supremacy were to disappear, owing to our country not possessing cheap fuel?

Would it not be more prudent and far-seeing to apply the funds now devoted to repaying the capital of the National Debt to the acquisition for the State of our railways, etc. From the revenue obtained, complete the repayment of the National Debt capital, during the considerable period, probably of a century after obtaining possession, when it would only be necessary to reduce the charges on our railways by a certain proportion only, still leaving a large revenue from the railways, plus the economies which would be secured in working them as one undertaking.

In this way the continued prosperity of the nation would be secured, as well as a fund be created, available for repayment of what may then remain of the National Debt capital.

Upon the assumption that the capital outlay upon

railways and docks, and the local charges for interest on loans for sanitation, water, etc., had ceased, rates and taxes would be reduced to a minimum, and ultimately, as the necessities of the commerce of the country required, the cost of traveling and the rates chargeable for goods, minerals, and live stock could be gradually from time to time lowered, until these charges are reduced to the bare working expenses.

This operation, if carried out, would have the effect of materially reducing the cost of living, food, and clothing, rent would be less costly, and labor would probably become much cheaper.

The whole of the indebtedness of this country for railways, docks, drainage, and water, and lighting may be estimated approximately at 1,500 millions of money (of these the first four mentioned are in private hands, the others are owned mainly by public bodies); if the interest upon this money were to cease, it would relieve the nation by at least £60,000,000 per annum, and this upon 250,000,000 tons of coal represents an amount which would more than counteract any increase in the cost of coal due to natural causes alone, until the practical exhaustion of our coal supplies.

If, however, this enormous capital is allowed to remain until the prosperous period of low cost of coal passes by, it would not be practicable to reimburse this capital, and the amount remaining unliquidated would become lost, and so cause widespread ruin to individual shareholders as well as to the nation.

What is suggested, therefore, as regards the railways is:

1. That either the reversion of the railways should be purchased by the government, taking effect at the end of say fifty years, and that afterward the railways be worked under government control, with such reductions in rates as the conditions of trade require; or

2. That the railway companies should be compelled by legislation to provide a sinking fund annually sufficient, at compound interest, to replace the whole of the capital which they have already created, or may create before the end of a period which the Legislature may fix after full inquiry. Part of the investigation would involve an inquiry as to how the amount of the sinking fund is to be obtained.

In the second event, at the end of the period, either the working of the railways should be taken over by government or continued in private hands, subject to governmental regulation, and absolute power to the State of reducing rates from time to time, and the surplus revenue, if any, during the earlier period when the increased cost of coal would not be so heavy, beyond the working cost, could be apportioned between the railway companies and the imperial revenue as might be decided.

A similar proposal might apply to docks, and modified conditions to the trading investments of municipalities. The compulsory repayment within a given period of the capital invested in lighting, water, and drainage would afford facilities for reduction in rates and taxes in those municipalities in which the capital had been repaid.

Now, the fact is undoubted that the cost of working coal will gradually increase owing to natural causes alone, and that the increase will begin to affect the industrial power of the nation seriously in half a century or thereabout.

It is also a fact that there will still exist at that time large coal resources equal to more than a couple of centuries on a consumption of 250,000,000 tons per annum, or 25 per cent. more than the present annual output.

Are we to lose by neglect the profitable use of this enormous annual wealth, or shall we in time take such measures as will enable us to continue to utilize it? That the emergency will arrive cannot be gainsaid; the remedy, if a remedy can be found, is open to argument and inquiry; but the present is the time to make the investigation, and not when the actual contingency is at our doors. It is no answer to urge that our successors can take care of themselves. They will not have created the capital or had the benefit of the use of the capital, but if left to them unliquidated, it will weigh as a millstone around their necks.

Finally, I may glance at the objections which have been raised to the adoption of the suggestion advocated by the writer, viz., of paying off the nation's indebtedness in railways, docks, waterworks and gasworks, sanitary and other capital outlays, during the period when the production of the cheapest and best of our coal resources secures to the nation a commercial prosperity which cannot be hoped for after the exhaustion of the best of our coal resources.

The chief of these objections are: (1) That science, before the expiration of fifty years, may discover some efficient substitute for coal; (2) that the State purchase of the railways will place too much patronage and power under government control; (3) that the railways will not be efficiently managed under State control; and (4) that the altered conditions under which the nations compete commercially fifty years hence may be so changed as to render the possession of coal fields not necessarily of paramount value.

Objections 1 and 4 may be considered together. To refuse to face the position in the hope that something may happen within the fifty years is tantamount to hiding our heads in the sand and waiting for something to turn up. If some discovery of science provided an effectual substitute for coal, however improbable, we should not in Great Britain have a monopoly of such substitute, but should have all the civilized nations competing with us. How infinitely stronger our national position for such competition would be if transport and inland communication, by reason of the repayment of the capital value of our railways have been effected, was reduced by one-half of what it is to-day, and our rates and taxes, by reason of the repayment of our municipal loans, reduced to a minimum.

It would appear to the writer essential, whether we look at the question from the point of view of extending the period of the profitable working of our remaining coal resources, or from the point of view that at a certain period an efficient substitute for coal will be found, that the clearing off the national liabilities, in means of communication, during the nation's prosperous period, would not only be the soundest of policies, but the only reasonable and prudent course to adopt. A prudent individual, providing for his successors, would undoubtedly adopt such a line of conduct, and if to an individual it is desirable, surely it is of paramount importance to a great nation to follow a prudent policy.

Then objection No. 2, that the State purchase of railways will place too much patronage and power in the hands of government. I am aware and appreciate the serious objections to the course suggested from a political point of view; but the question whether we, as a nation, are to collapse financially in half a century or continue to maintain our position for centuries, is altogether too serious to become the catspaw of any political party. If, however, the result sought of enabling the nation to reduce the cost of traveling and transit of goods and minerals by one-half, when required after half a century, and a reduction in rates and taxes, can be equally well secured without the State purchase of the railways, then I should be content. The wit of our politicians surely can find some solution outside party politics of preventing the control of so many voters being used for party or government purposes.

Possibly one way out of the difficulty is that suggested by compelling the railway companies to fund a portion of their income to repay their capital in from fifty to seventy years, the State being able to control absolutely permanent reductions of rates of carriage from the end of fifty years. This reduction would, as previously explained, be necessarily gradual, and only reach the minimum of the bare cost of working and management at a period considerably later than fifty years. If the course last named were adopted, it would meet the third objection previously mentioned—that the railways will not be efficiently managed under State control.

I have now placed before you the problem of our coal supplies. The total supplies at the present and prospective rate of output will last probably three centuries, but the cheapest will only last half a century. That if we do not during that period of fifty years provide in some way to meet the gradually but steadily increasing cost of our coal, after fifty years, owing to natural causes, we shall be unable to compete successfully with America and the East, and it must follow that our commercial supremacy will disappear, while, it is suggested, if the capital value of our railways and other works were paid off in the fifty years, and the cost of traveling and transit of minerals reduced by one-half, the increased cost of our coal, due to natural causes, would be practically neutralized, and the nation would be able to hold its own so long at all events as the coal resources of the country endured.

Is this not a question worth the serious present consideration of politicians and the nation, although the actual emergency may be approximately half a century hence?

If the remedial measures suggested are inapplicable, or if other measures are preferable, we ought to tackle them. The subject is worth investigation, even if no practical remedy can be found; it would be only prudent to face the difficulty, with a full knowledge of what we may expect as the future prospects of our country.

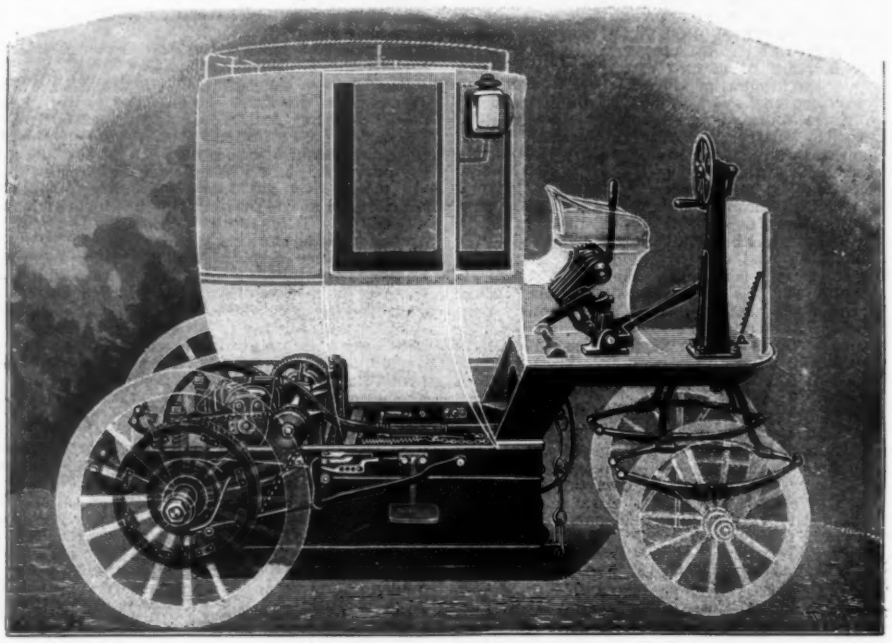


FIG. 1.—GENERAL VIEW OF AN ELECTROMOBILE HACK—DETAILS OF THE MECHANISM.

ELECTRIC HACKS AT PARIS.

ELECTRIC hacks, which have been awaited for a long time at Paris, have finally begun their service. The Compagnie Générale des Voitures, whose manager, M. Bixio, is well known to Parisians, has had the subject of automobile carriages under study for some years, and it is not until after a detailed examination of the respective advantages and disadvantages of the different methods of propulsion in cities like Paris that it has fixed its choice upon electricity as a motive power.

Fig. 1 shows the general arrangement adopted by the company for its new vehicles, and allows us to observe all the peculiarities of it. The truck, which is of steel, is mounted upon four wheels provided with rubber tires. It receives the driver's seat, the electric motor, the controller, and the steering apparatus.

Upon the truck is fixed the body of the vehicle, of whatever kind it may be, three-quarter coupe, vis-à-vis or landaulet. The bodies, moreover, are interchangeable. Pneumatic tires are not employed for fear of the accidents that would be sure to happen on the road through running over nails, tacks, broken glass, etc.

The driving wheels are the two rear ones, the front wheels being used for steering. A bipolar electric motor of 3,360 watts capacity at 80 volts actuates,

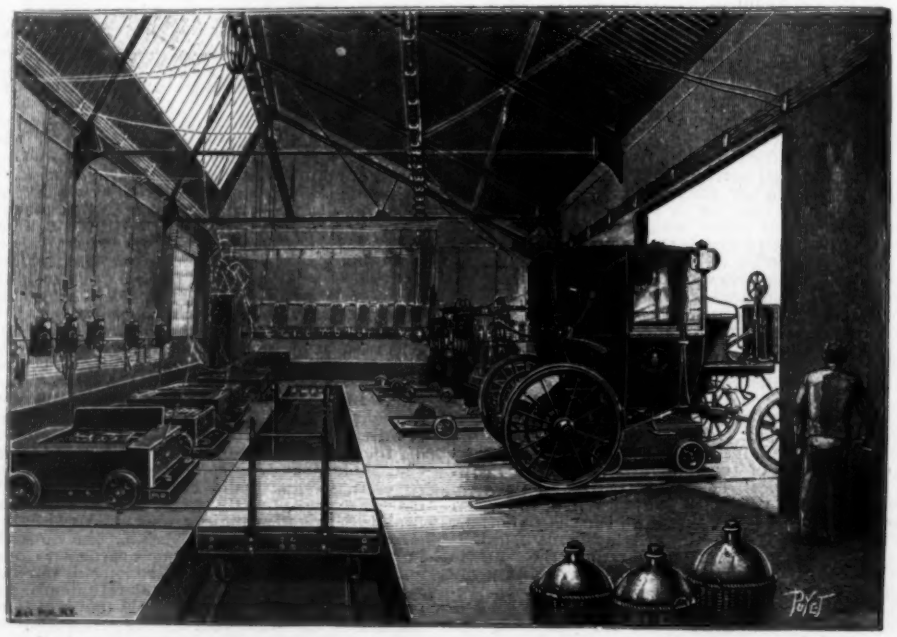


FIG. 2.—INTERIOR VIEW OF THE CHARGING STATION ON RUE CARDINET.

through gear wheels that may be seen in Fig. 1, a differential gearing supported by strong bearings which are automatically lubricated. The main shaft, upon which the differential gearing is placed, has a small sprocket at each end which drives the hind wheels by means of an endless chain of special construction. The entire driving mechanism is placed under the rear seat of the carriage. It rests upon a jointed frame, which is supported by spiral springs.

The electric energy is furnished to the motor by accumulators; positive plates are of lead and negative of lead oxides. These accumulators are forty-three in number, and weigh 1,650 pounds in a carriage that has a total weight of 4,400 pounds. They are inclosed in a box which is suspended from the truck by means of four spiral springs. This arrangement permits of removing the battery for charging and of easily putting it back in place during the ordinary service of the vehicle.

The capacity, which is 135 ampere-hours, permits of making a trip of about 36 miles. The driver's seat is in front. To the left is placed the special lever which actuates the controller that permits of controlling the speed. In a vertical position, the circuit is broken, and the carriage is at a standstill. At the back and front there are respectively four and three keys over which the lever may be moved and which correspond to variable couplings of the motor armature with the cells in series and multiple.

In this way the vehicle is made to run forward slowly or with different degrees of speed. Reversing the lever applies the brake, and also causes the vehicle to run backward.

Upon coming to a standstill, a safety key permits of breaking the circuit so that no one can use the carriage during the driver's absence. The driver must always carry this key with him.

Steering is accomplished by gearing that transmits motion to the front wheels, which are connected to a vertical handwheel.

The brakes are three in number. One of these, which is electric, permits, by pulling back the lever, of reducing the speed and even of stopping the vehicle suddenly in case of necessity. The two other brakes are actuated by pedals located under the seat. One of them is a block brake, which acts upon the felly of the hind wheels, and the other a band brake that acts instantaneously upon the hub of the same. These three brakes assure entire security—much greater security, in fact, than with animal traction.

The speed authorized must not exceed 9½ miles an hour in Paris. The experiments undertaken by the Compagnie Générale des Voitures indicate that the energy absorbed will be somewhat more than 350 watt-hours per mile run upon a level.

Such, then, are the principal arrangements adopted, and all of them have been studied with care.

It now remains to speak of the station for the production of electric energy for charging the accumulators, and of the school of apprenticeship for the drivers.

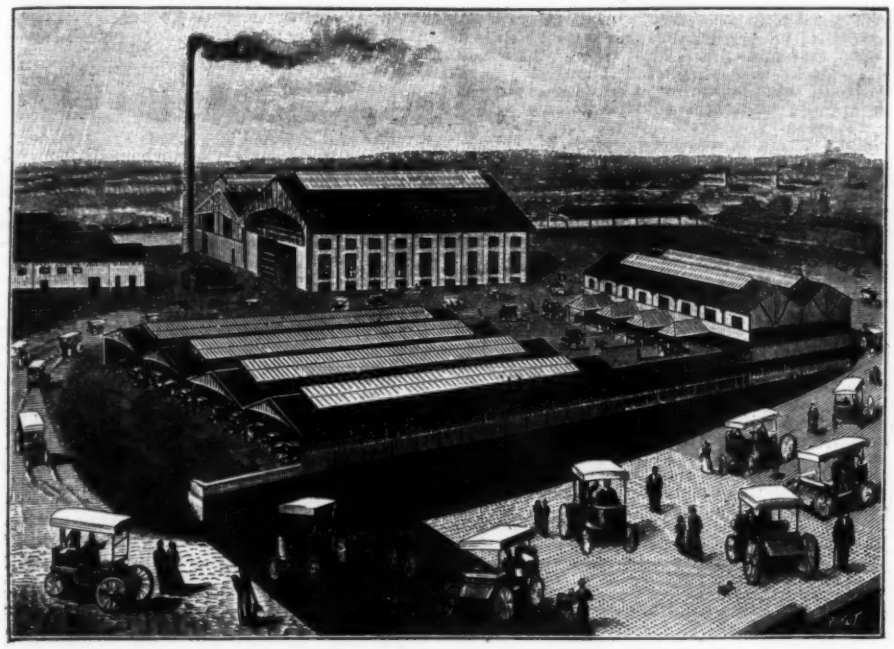


FIG. 3.—THE AUBERVILLIERS ESTABLISHMENT—ENGINE BUILDING, CHARGING HALL, CARRIAGE HOUSES, AND TRACK.

For the experiments which it has been carrying on for some time past, the Compagnie Générale established at 112 Rue Cardinet a station for charging accumulators both for its ordinary vehicles and those used for the instruction of its employes. The electric energy is furnished by the Clichy sector. Fig. 2 gives an interior view of this establishment. At the back, to the right, is situated a rotary transformer formed of two dynamos coupled to the same shaft. One receives a current at 440 volts, acting as a motor, and running the other, which serves as a generator and furnishes 130 amperes at 110 volts. A distributing circuit starts from the switch board and runs along the wall to the left, where a number of smaller switch-boards are placed. When a carriage reaches the entrance of the hall, a movable platform is placed under the accumulator box, which is lifted by an hydraulic elevator. The accumulator box is unfastened, the platform is shoved up against the wall, and the battery is submitted to the process of charging. The reverse operation is performed for placing a box of charged accumulators under a carriage. The station on Rue Cardinet has, as above stated, been used also for charging the batteries of the vehicles for the instruction of drivers. These vehicles, which are of a special model, have been operated for several months under the supervision of M. Gourdon, and, through exercise on a track of which we shall speak further along, it has been possible to obtain skilled drivers for automobiles.

After the experiments appeared to be conclusive, the company began to occupy itself with the arrangement of a special establishment for the charging of accumulators on a much larger scale. This new establishment, a general view of which is given in Fig. 3, is situated on Rue du Pilier at Aubervilliers and occupies a total surface of eight acres. To the left may be seen the works proper, containing the boiler room and the engine room, in which there are at present two groups of 250 horse power motors. A little to the rear and to the left stands the charging building, and toward the right there is a structure large enough to accommodate 200 vehicles. In front, in our engraving, may be seen a portion of the track.

The charging building is several stories high and has a large free space in the center. The carriages enter on the ground floor, where the accumulators are unloaded upon trucks and are replaced by others that are already charged. The batteries are afterward raised by elevators to the first story above, where they are recharged. There are three of these elevators, each of which is capable of lifting 2,200 pounds.

All around the establishment, for a length of 2,300 feet, extends a track for the training of the drivers. This track as shown in the front part of Fig. 3 is formed of ground of variable nature having gradients of 5, 8, and 10 per cent., with wood, macadam, asphalt, bitumen, Belgian and other pavements. In order to get the drivers accustomed to making their way amid obstacles, M. Gourdon has distributed over the track wrought iron figures of men, women, children, nurses, bicyclists, etc. The drivers are thus able to obtain the same experience as they would if they were upon a busy Parisian thoroughfare. In Fig. 4 will be seen one of these training vehicles that has just passed alongside of a bicycle. The company is going to watch very closely the results furnished by the hacks that have just been sent out, and if all goes well, as it is hoped that it will, the new type will be definitely adopted, and 1,000 hacks will be put in service for the Exposition of 1900.

For the above particulars, and the illustrations, we are indebted to La Nature.

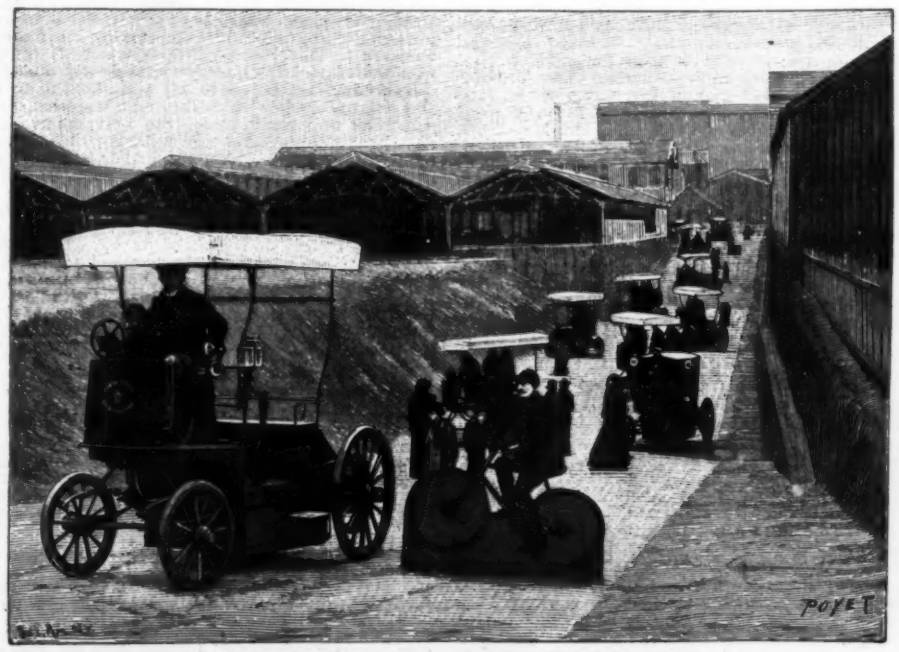


FIG. 4.—TRACK FOR TRAINING THE DRIVERS OF AUTOMOBILES.

CLOTH PRESSING BY ELECTRICITY.

AT a recent meeting of the Industrial Society of Elbeuf, a report was made by Mr. Ch. Mouchel, on a new process invented by Mr. Chedville, which is known as the "electro-calidor" process, and consists of pressing cloth by means of boards heated by electricity.

A special committee appointed for the purpose examined the manufacture and operation of the press boards. The result is declared to be most satisfactory, and the report is as follows:

"The body of the press board is composed of asbestos paste covered by a netting of German silver. This is again covered by paper pulp, which gives a pliable surface without materially increasing the thickness of the press board, which measures from 2 to 4 millimeters (0·078 to 0·157 inch). The first experiments were made by applying the electric current through holes pierced in the portion of the board projecting beyond the cloth. Experience, however, has led to the adoption of press boards with a trapezoid projection, of which the two obtuse angles are covered with copper. Spring clips, provided with a metal connection and attached to a pliable conductor, serve to transmit the electric current to the copper covered corners of the boards, when the press is arranged for work.

"The electric press boards are used in the following manner: On a plate of sheet iron is placed a piece of cloth, between the folds of which are placed at equal distances three electric press boards; then there is another plate of sheet iron, another piece of cloth, and so on until the press is full. An ordinary press holds eight pieces, the folds of the cloth being one meter (1·09 yards) wide.

"The Messrs. Blin employ a system of hollow presses, and an iron track, sufficiently long to accommodate ten, communicates with each one of their hydraulic presses. Against the ceiling and parallel with this track are arranged two conductors, one positive and one negative. They are placed on either side and a little beyond the line of the track. Large clips for transmitting the electric current are attached by pliable wires to these conductors. The hollow press is then placed between two of these clips, each of which communicates with a movable vertical distributer.

"The distributer is a simple grooved rod, the conductor being placed in the groove. Thirty pliable wires, each terminating in a spring clip, hang at an equal distance from this distributer.

"The clips are readily adjusted to the metal corners of the electric press boards, the positive on one side and the negative on the other. The current is thus established and the proper degree of heat generated, the time necessary varying from three-fourths of an hour to one hour and a half.

"The required current for a press board measuring 1 meter (1·09 yards) by 70 centimeters (27·5 inches) is 2 amperes under a pressure of 110 volts. A press of eight pieces, with twenty-four press boards, demands a current of 48 amperes to heat the press, and the amount of electric force expended in one hour and a half is as follows: $48 \times 110 \times 1{\cdot}5 = 7{,}920$ watts per hour. The mechanical force given a dynamo of 90 per cent. working capacity is $\frac{48 \times 110}{736 \times 0{\cdot}9} = 12{\cdot}5$ horse power. The labor expended in one hour and a half is as follows: $12{\cdot}5 \times 1{\cdot}5 = 18{\cdot}75$ horse power per hour.

"Supposing a consumption of 1·5 kilogrammes of coal per horse power per hour, the quantity of coal necessary to heat a press may be estimated at about 30 kilogrammes (66 pounds). Estimating coal at 25 francs ($4.83) per ton, the maximum cost of heating a press would then be 75 centimes (14 cents).

"Comparison being made between the amount of coal required by the new system of pressing and the old—viz., direct heating in a special oven by means of sheet-iron plates interspersed between the folds of the cloth—it is found that the old method is slightly dearer than the new, as the Messrs. Blin, who used the old system with as little waste as possible and had thirty presses per day, state that they use at least a ton of

coal a day for the heating of their plates, which involves an expenditure of 33 francs ($6.37) for the presses used, or 1·10 francs (21 cents) per press.

"There is thus an economy of fuel, but the new system has other and more important points of superiority.

"The first is the perfection of the work. The heating of each press, and even of each piece, can be regulated mathematically, either by varying the number of press boards or by increasing or diminishing the length of the heating. The cloth is heated slowly and without the inequalities resulting from the old system, under which the two ends of each piece were almost in contact with plates heated to 500°. All manufacturers who have employed the new system speak of this point as a great advantage.

"A second advantage is the extreme cleanliness with which the pressing can be effected. The old style of plates heated in an oven often resulted in soiling the cloth, which is now entirely avoided.

"Another advantage is the economy in laborious handling necessitated by heating and transporting heavy cast iron plates. The workshops can also be kept at a lower temperature, more favorable to the health of operators.

"The heat generated in the folds of the cloth is completely utilized by the new process, and a fraction less is lost by radiation than under the old system of heating by plates.

"If there is already an electric plant in the establishment (and few modern houses devoted to commerce or manufacture are without one), the expense is reduced. The boards are not costly, and with proper care will last several years."

Mr. Mouchel thinks that the process above described is, from all points of view, a most important invention and should be generally adopted.

W. P. ATWELL, Commercial Agent.

Roubaix, January 18, 1899.

THE DAMMING OF THE NILE.

THE Nile, in far-off geological periods, was a much larger river, but then it still had the same annual surcharge of waters which we call "High Nile." This is proved by great banks and terraces of stratified mud, high and dry above the highest Nile of these days. . . . There were traditions and historical tales of the early Egyptians having stored up the floods, and there are beds of old canals that the Nile waters could not now supply, even at flood. No traces of such ancient dams exist, but there may have been natural barriers of rock, now worn away, which held up the water to supply these ancient canals. Egypt generally bears two crops in the year; it can be made to give three crops and even four crops in some districts. In order to give perennial irrigation to Egypt, and increase the yield of the cultivated land, much more water is needed than before. Nine-tenths of the Nile flood goes to the sea. Store it up somehow, and the Delta will yield three or four crops a year, and the thirsty land will never want supplies. This thought must have occurred to anyone standing on the spot ten miles below Cairo where now stands the great Barrage, the only existing dam throughout the whole length of the Nile. But the French, who made it (but did not make it do its work), give the credit of its inception to the great Napoleon. . . .

The rule of Napoleon was cut short, but his idea had been published, and bore fruit in time. Mehemet Ali, the famous Egyptian leader in the early part of this century, had shaken off the blighting Turkish rule, while his wars and his attempts to make Egypt a great nation, combined with his own extravagance, caused a great demand for money. To supply his exhausted exchequer, he introduced the growth of cotton, sugar, rice, and other crops new to Egypt, requiring water in enormous quantities, and at the very time when the Nile was low. Then he bethought him of Napoleon's project. Various French engineers were summoned to carry this out. One ventured to suggest a great stone embankment. "Well, then," said Mehemet Ali, "you have those great useless heaps of stone, the Pyramids; use them up, every block, for the purpose." The engineer knew that infamy would attach to his name if he agreed to this proposition, and asked some days to make calculations. His master would only allow him one day. When the engineer again appeared, he said the cost of transporting the stone from the Pyramids would be greater than to quarry it anew in the mountains. "Then let the Pyramids stay, and quarry new stone," said the tyrant, and so the monuments were saved. Mehemet Ali planned his Barrage in 1833, but the plague came, killed his fellaheen (laborers) by thousands and thousands, and so even the tyrant had to cease work for several years. It was, therefore, not till 1837 that the actual Barrage we now see was begun. It was Mehemet Ali, by the way, who made the great Mamoudieh Canal conveying the Nile to Alexandria. He tore villagers, men, women and children, from their homes, and compelled them (under the lash and unpaid) to work without tools, burrowing the earth out with their hands. The canal, thirty-six miles long, was made in one year; 250,000 were employed, but 25,000 of them died at the work.

The existing Barrage was designed and planned by a Frenchman, Mougel Bey, who had been long in the viceroy's service, and who must have been a man of genius and of considerable artistic taste. It is probable that the foundations intended by such a talented man would have been properly laid had he been allowed to employ skilled workmen, but he had only thousands of poor half-starved fellaheen, and when the work delayed, extra thousands were sent down, only to spoil what had been done, or do indifferently anything new. Millions of tons of stones and gravel were thrown into the river bed, and on this cement was poured, often under water. On such unreliable substructure was piled the vast dike of masonry, pierced by 120 arches, carrying sluices and roadway, and upward of a mile in length. Skilled labor had to be now employed, and the cost became enormous. Mehemet Ali died in 1848, before it was finished. Under his successors the work went on. At length, in 1861, it was declared completed, but no one ventured to use it to dam up the full pressure of High Nile. The river was only kept back enough to raise the level a few feet. However, in 1863 it was thought that the dam would by this time have been consolidated, and some venturesome engineer closed the sluices and let the waters rise. Immediately, the unfortunate barrier cracked in several places, and began actually to move down stream! The sluices were all quickly opened, and the movement stopped. The extent of its northward progress can still be seen, about 100 feet of the parapet being out of line to this day.

Various experts were called in during the next few years. Some, like Sir John Fowler, suggested spending £1,500,000 more to save it. It had already cost four millions sterling. Not only did the masonry threaten to move off to the Mediterranean, but the sills cracked, and springs of water began to boil up everywhere below the arches. Other experts advocated the whole affair being blown up with gunpowder, but even this and the removal of the vast masses of masonry to free the passage of the Nile would have cost £500,000. Time went on. A costly staff was maintained to keep the sluices always open, and to be constantly repairing the whole work. Then came the events of 1882, and with them the British arrived upon the scene, and Lord Dufferin was sent from Constantinople to advise a plan of action to save the country after the disastrous effects of Arabi's mutiny. His masterly reports to Lord Granville have been published as state papers, and his advice has undoubtedly saved Egypt from hopeless ruin and insolvency. All the revenue of Egypt comes practically from the Nile, and Lord Dufferin's wise counsel to borrow some of our Indian officials and irrigation engineers was carried out, and Sir William Garstin, Sir Colin Moncrieff, Sir Alfred Milner, Major R. H. Brown, and Mr. Willcocks, among others, came into power. Sir Colin Moncrieff and Mr. Willcocks were asked if the Barrage should be abandoned and destroyed at a cost of half a million.

They spent much time in boring and experimenting, and at length Sir Colin Moncrieff reported that for a similar sum he would undertake to save the structure. Lord Cromer backed him up, the work was done, and soon the Damietta section was completed and at work. Then the other section was taken in hand. The Barrage has been in full work ever since, and has long ago repaid in increased water-supply every penny of the money expended on its salvation. The Barrage, spanning the two arms of the Nile, is upward of a mile in length, and consists of 120 arches, with double sluices in each, and a broad roadway along the top. The sluices allow the muddy deposit to free itself, so that the reservoir can never fill up, and yet the 20 or 30 feet of water can be dammed up at the proper season. Stony's patent sluices are now being applied, by which a child, by moving a lever, can elevate or depress a mass of solid steel, 20 feet by 12 feet, with all the pressure of the Nile upon it.—Pearson's Magazine.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

Automatic Car Couplers in Europe.—A recent discussion in the British House of Commons regarding the enactment of a law compelling all railways in the United Kingdom to equip their rolling stock with automatic couplers has started agitation along the same lines in Germany, says W. K. Anderson, consul of Hanover. As in all matters pertaining to the safety and comfort of employes and of the traveling public, our railways are, in this respect, far in advance of those of other countries. Years ago, the railway companies in the United States were ordered to adopt automatic couplers, and were given a term of six years within which to complete the alteration of all of their cars. This term was afterward extended for a shorter period, in order to give certain roads which had not been able to fully comply with the law a further opportunity to do so. In the meantime, all new cars have been equipped with improved couplers, and the law may now be said to be in full operation. It is claimed that the dangers incident to the occupation of a brakeman have been reduced to a minimum by this means.

The need of adopting similar measures was urged long ago in Prussia, before the era of state railways. At that time, the German Railway Union offered a large reward for the best safety coupler. The Prussian State Railways, however, although much more progressive than other Continental roads, have, for some unexplained reason, relegated the matter to the rear, and apparently postponed its consideration. The surplus earnings of the Prussian railways for the past fiscal year were the enormous sum of 528,000,000 marks (equal to about $125,000,000), and advocates of the safety couplers hold that some of the said earnings might well be appropriated for this purpose. In the fiscal year 1895-96, 250 railway employes in Prussia lost their lives by accident, and 550 were injured. In 1896-97, the figures were 264 killed and 667 injured.

In the British House of Commons, Mr. Maddicon stated that from 1888 to 1897, a period of ten years, 4,757 railway employes in the United Kingdom lost their lives in coupling cars, while 30,271 were severely injured. In 1897, an average of 1 brakeman in every 274 was killed, and 1 in every 15 injured; and, among the shovers and pushers, 1 in every 203 was killed and 1 in every 12 injured. Mr. Burns supplemented these figures with the astonishing statement that in twenty-five years—viz., from 1872 to 1897—among 1,500,000 English soldiers, 1,396 were killed in battle, while for the same period 9,000 railway employes were killed, proving that railway employment was much more dangerous than war. The correctness of these statistics was acknowledged.

Some time ago, the British government sent the expert Hopwood to the United States to examine on the spot the workings of the prescribed automatic couplers, and he reported very favorably, stating that, although they were not at that time in general use, the number of casualties among brakemen had already been reduced 50 per cent. The railway managers in England have been conferred with, and a draft of a bill has been worked out to bring about the introduction of safety couplers. The House of Commons has approved it, and it will soon come up for final passage in Parliament.

Trade Suggestions for Scotland.—Some months ago, in a brief report on suiting methods to markets, I expressed, says United States Consul Rufus Fleming, of Edinburgh, the opinion that the great majority of Scottish business men handling American manufactures, or willing to handle our goods, preferred to deal directly with the manufacturers rather than with middlemen, either on this side or on the other side. Certain exceptions to this rule were noted, such as the bicycle trade and typewriter trade, which are specialties and have been managed in an exceptional way from the start. Further observation in and intercourse with the business community have confirmed this opinion. The Scottish wholesale dealer, who is in the habit of getting 5 per cent. discount on the invoiced price for cash or 2½ per cent. at one month in general lines of merchandise, does not like to look upon an invoice that he thinks may contain a middleman's commission. He does not object to paying a price which may include an agent's commission, but he draws a broad line at that. I have talked with agents on this subject. They quite agree on the proposition that an American manufacturing company or firm seeking to extend its trade in this country should offer to deal directly with buyers, and take all orders directly, not to be duplicated to a representative company or bureau. In undertaking to secure an agent in Edinburgh for an association in one of the Middle States, representing manufacturers in various lines and requiring a duplication of orders, I have met with a very emphatic objection:

"This will not do. The goods are expected to yield a profit to the manufacturer, a commission to the middleman, a commission to the agent, and a profit to the dealer on this side. That's too many slices of pie, and all must be thin."

In the keen competition for trade the commission agents or merchants—who are the essential men—offering American goods find themselves at a disadvantage, as a rule, if the goods are not shipped from America to Glasgow, Edinburgh, or Dundee, or the nearest port to the customer. For instance, an Edinburgh man who represented an American manufacturing company having a general agent and warehouse in London severed his connection with the business recently, because he could not meet the prices of another American company in the same line shipping direct to a Scottish port. The freight rate on the wares from New York to Edinburgh is but slightly, if any, higher than the rate from New York to London. The rate from London to Edinburgh by water is as high as from New York to Edinburgh or Glasgow. By rail, the rate on goods from London to this city is considerably more than the steamship rate charged from New York to Edinburgh. On goods of the kind handled by this agent, the freight from London for a quantity worth about $50 is $7.50. This made it impossible for him to compete with the company shipping from New York to Glasgow, and, as I have said, he resigned the agency.

The American manufacturer who gets closest to the market—to the local dealers—will get the trade. Take the case of a large American furniture manufacturing company as an illustration of one way to make business in a foreign country. This company sent its own men over to "set up shop" in London and Glasgow. The furniture—household and office—is shipped from their factories to this side in the rough. Being in parts and tightly packed, it occupies little space and pays the minimum rate. It is put together and finished in the London and Glasgow workshops of the company, and salesmen place the furniture before dealers in England and Scotland. This enterprising company has, I am told, a profitable and growing trade.

With reference to business methods, it may be worth noting that the commercial traveler as a factor in trade getting in the United Kingdom was never so prominent as he is now. Some of these traveling salesmen are paid salaries without commission, and others have salaries with commission. Of those resident in Scotland with headquarters in Glasgow, Edinburgh, or Dundee, I have met several, each of whom represents a London house in one line of goods, and under his contract can handle at the same time different lines of goods for foreign houses if he chooses to do so. To introduce their goods, American manufacturers or exporters who would not feel justified in going to the expense of maintaining traveling agents of their own could hardly do better than to secure the services of such men to sell on commission. Some American manufacturers have made good connections of this kind. This has been the practice of German houses in beginning business in the United Kingdom. In a recent conversation, an Edinburgh commercial traveler told me that he built up an excellent trade for a German manufacturing company in the chemical line a year or two ago, which was so highly appreciated that the company sent over a man of their own "just to meet a few of our customers," and he has not returned to Germany, but has taken charge of the flourishing business in this country, dispensing with the agent who had created the business or at least promoted it.

It is almost needless to say that, next to an active and reliable agent with a thorough knowledge of the wholesale and retail trade, the best connection an American manufacturer can make is with a wholesale house buying direct. A useful article will win its way if put on the market at a moderate price, even if it be not advertised or otherwise pushed to the front. As a notable instance, a little device, of American invention and manufacture, for perforating checks and drafts with the figures of the amounts for which they are drawn, has had a wide sale in Scotland during the past two years, although no special effort has been made to bring it before the public. Much the same thing is true of several other American specialties and of a few lines of staple goods and various kinds of machinery. They gain a market—slowly, perhaps, but surely—by commending themselves.

INDEX TO ADVANCE SHEETS OF CONSULAR REPORTS.

No. 420. May 8.—*Trade Suggestions for Scotland—Use of Phosphorus in Matches—Slate Industry in France—Orange Growing in Jamaica—Value of the Russian Ruble for Customs Purposes.

No. 421. May 9.—*Automatic Car Couplers in Europe—Manchester Exports to Cuba, Puerto Rico, and the Philippines—Kyao-chau Harbor Regulations—United States Dental Diplomas in the Netherlands.

No. 422. May 10.—Cotton Goods in Colombia.

No. 423. May 11.—Export Conditions in Austria—Traffic on Siberian Railway.

No. 424. May 12.—Diamond and Gold Mining in Minas Geraes.

No. 425. May 13.—Trade and Customs Regulations on the Yangtze Kiang.

The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. Interested parties can obtain the other Reports by application to Bureau of Foreign Commerce, Department of State, Washington, D. C., and we suggest immediate application before the supply is exhausted.

ENGINEERING NOTES.

A paper was lately contributed to the Paris Academy of Sciences on "The Mechanism of the Disintegration of Hydraulic Cements," by M. H. LeChatelier. The disintegration of hydraulic cement after some months or years cannot be ascribed to the hydration of free lime or magnesia, as the latter would be a matter of days at most, but, according to the author, would appear to result from two causes—the greater or less solubility of the active constituents of the cement and the variation of solubility of the solids with the pressure they support.

The Novoe Vremya states that in a lecture read before the Society of Marine Engineers, St. Petersburg, Messrs. Zvorykin and Blumenthal explained their invention for revealing automatically a leak on board ship. In the hold of the vessel a cage is fixed containing a lever with counterbalancing weight. The presence of water disturbs the balance and brings the lever in contact with an electric apparatus, which then lights a lamp in that part of the hold and rings a bell. Two of these contrivances are to be placed experimentally aboard the "General Admiral Apraksin" battleship.

A single-rail railway on the Lartigue system is the latest of the many projects for additional means of communication between Liverpool and Manchester (England), a distance of 30 miles. It is to be one of the often heard of, but never yet seen, railways having a regular speed of 100 miles per hour. Even 150 miles per hour is talked of. But the projector, Mr. B. F. Behr, sticks to steam as the tractive power. The Lartigue system has been used for an agricultural railway in Algeria and for a 10-mile railway in Ireland. It consists of a series of A-frames, connected by a carrying rail on top and two rails on the sides. The engine and cars straddle this structure and have horizontal wheels running on the lower rails to steady the train.

By far the largest system of drainage ever attempted in northern Indiana has been filed by the commissioners of Noble County. The main ditch is 10 miles long, and the width of the bottom varies from 11 to 16 feet. The digging of this canal will lower the water in High Lake 6 feet, Bear Lake 7 feet, Long Lake 6 feet, Mirror Lake 7 feet, Port Mitchell Lake 7 feet, and other small lakes which it passes about the same amount. In all there are sixty-six branches. The total length of the main ditch and laterals is 74½ miles. In a straight line they would extend half-way across the State of Indiana east and west. Of the ditch 20 miles are to be tile. The cost of construction will be $75,000. Altogether eighty sections of land will be benefited, or 51,200 acres.

Attention has been directed by W. Hempel to the practical application of air rich in oxygen obtained by liquefying air and partially separating the constituents by practical distillation. Linde has stated that a cubic meter of 50 per cent. oxygen can be produced at a cost of about 0·3c. The value of ordinary generator or producer gas is very greatly diminished by the large percentage of nitrogen it contains; this could be reduced to less than one-half by the use of air containing 50 per cent. of oxygen and the gas would then be available for general use for heating, and, if incandescent burners are employed, for lighting also. It is also suggested that the use of air rich in oxygen would enable results to be obtained with poor fuel that are now only effected with the best kinds of coal.

Auto-sighting for fortress artillery has now become an adopted practice in the British service—thanks to the persistency and skill of Sir George Clarke. According to his system, the gun fitted with this system of sighting has only to be laid for the object and fired as fast as possible. Sir George himself thus defines the problem in the "Proceedings" of the Royal Artillery Institution: Given the height of the gun above the sea level at any moment, the angle of depression of the line of sight evidently determines the range. It is required, by mechanical arrangements connecting the line of sight with the gun, to insure that when the former is laid on the water line of any floating target, the latter shall automatically take up the quadrant elevation corresponding to the range. In other words, the sight must be moved by the gun, the latter being elevated or depressed till the former comes "on" with the target. A series of trials have lately taken place, in which two auto-sights were fitted to two 4·7 mountings, and the results are described as eminently satisfactory. The successful introduction of auto-sights would contribute immensely to the effectiveness of fortress artillery, while also useful from the point of view of economy.

For the construction of a mole at Mostaganem, a Titan crane of formidable dimensions was employed. It consisted of a truck, resembling a flat arch and moving on rails on the customary four rails, and a girder bridge. The whole bears a strong resemblance to a swing bridge with two arms of unequal length. The total height of the Titan is 37 feet, the greatest length is 191 feet; it lifted 60 tons at a distance of 50 feet from the pivot, and 40 tons at double that distance, and weighed in itself, with its machinery, 266 tons. One day the sea began to play with this monster and turned it over, the legs sticking out of the water. There it remained almost two years, in 40 feet of water, until an engineer of Algiers, Caffaret, attempted its rescue. The attempt has been crowned with success, and at present the Titan is again in working order. The raising was accomplished, as we read in La Revue Technique, with the aid of mats consisting of beams and 192 casks. The air and the masses of wood together exercised a lifting power of 125 tons, amply sufficient to raise the truck to a height of 4 feet above the water level after the bridge, whose pivot had badly rusted, had been separated from it. With the help of floating cranes and a gradually rising stage, the truck was finally brought to the level of the quay. The bridge was dealt with in a similar way. The casks were first filled with water, loaded with iron, fixed in position, and then charged with air; one man could fix up to twenty casks a day. We might have pointed out that such Titans must, of course, have a clean sweep, so that a great deal of the machinery has to be placed on the bridge; thus, they become top heavy.

ELECTRICAL NOTES.

A hanging railway over the Seine will be one of the attractions of the Paris World's Exhibition. The railway will connect both banks of the Seine and be driven by electricity.

The approximate mileage of the telegraph and telephone lines of the world is 2,029,893, says The Engineer, and the miles of wire amount to 8,254,004; of telephone lines only there are 382,417 miles, involving the use of 3,202,950 miles of wire.

The negotiations for the establishment of direct telephone communication between France and Germany have resulted in an agreement on the main points. It is proposed to lay a line between Paris and Berlin, and another between Paris and Frankfort, and as the latter city is already in communication with Berlin, there will be two separate lines between the two capitals.

In the case of Moses vs. Pittsburg, etc., Ry. Co., 21 Ill. 523, decided in the year 1859, Chief Justice Canton said: "Cars upon street railroads are now generally, if not universally, propelled by horses, but who can say how long it will be before it will be found safe and profitable to propel them with steam or some other power besides horses?" This sounds like prophecy of the first water.—Electrical World.

The Capell fan has been selected for the ventilation of the Hoosac tunnel, and is being constructed by an engineer at Pittsburg, who is the licensee for the Capell fan in the United States. The fan will be 16 feet diameter by 8 feet wide, with double inlets. The guarantee is for 600,000 cubic feet of air per minute, which, irrespective of friction, means moving over 20 tons of air per minute, 13 cubic feet of air weighing, roughly, 1 pound. The power is to be electric, supplied by the North Adams Electric Company, Mass.

The Elektrotechnischer Anzeiger states that a 150-ton electric crane is shortly to be erected in Kiao-Chow Harbor. It will be fitted with two winding gears of 75 tons capacity, which can be used singly or coupled, and a smaller winding gear of 2½ tons capacity. It will be driven by two 100 horse power motors, and the swinging extension of the gib will be capable of bearing 70 tons in its lower and 150 tons in its upper position. Two additional 100 horse power motors are employed to actuate the gib extension, and a 20 horse power motor to turn the crane. The order for the crane was placed with a German firm.

The application of electric motors to the working of machines in steel works is advancing at a very rapid rate, e. g., charging and drawing machines for placing ingots and slabs in heating furnaces and machines for charging stock into melting furnaces are now quite common. A considerable development has taken place in the use of electro-magnets to lift plates, bars, and ingots. Formerly a plate was lifted by hooks catching the edges, the hooks being at the ends of chains actuated by a crane. Now the magnet is simply applied to the center of the plate, the current is switched on, and the plate raised by the crane carrying the electro-magnet. When the plate is placed where it is wanted, the switch is again turned, and the plate released and left in position.

Upon authority of the United States consul at Clifton, Ont., it is announced that the Canadian government has decided to construct a telegraph line to connect the Yukon territory with British Columbia, and that a party of engineers has already been sent north to commence the work without delay. The plan of the Minister of Public Works is to construct the line of telegraphs between Lake Bennett and Dawson City at once. At the same time surveyors will examine the country northward from Quesnelle, British Columbia, which is the terminus of the present government system, known as the old Cariboo line, in order to connect with the line to Dawson. The ministers have decided that the franchise for the telegraph line to Dawson is too valuable and too important from the standpoint of the national safety to be intrusted in other than government hands, and, accordingly, the enterprise will be conducted and controlled entirely by the Dominion government.

It is well known that the conductivity of an incandescent lamp filament increases during the first few hours of the operation of a lamp, and that after this first increase it decreases steadily during the entire life of the lamp. According to an authority on the subject, this initial increase in conductivity is due to the perfection of the carbonization of the filament by the temperature of operation. The process of carbonization converts the cellulose thread, which is a combination of carbon, hydrogen, and oxygen, into almost pure carbon, thus making a conductor of the perfectly non-conducting cellulose. The conversion, however, is not complete, and in the finished filament there is still some hydrogen. The process continues in the filament after the lamp has been placed in service, and this completion of the carbonization process is the principal cause of the increase of conductivity during the early hours of a lamp's life, says The American Electrician. As soon as this is completed there is a decrease in conductivity, due probably to a slight wasting away of the filament, as is made evident by the sooty deposit upon the globe of the lamp.

Reference is made in a British consular report on the trade and commerce of Charleston, S. C., during 1898, to the Charleston and Seashore Railway, which has been put into operation during the past year. This enterprise includes the new Sea Island resort 10 miles from the city, which is the property of the company, the terminus of its line, and the objective point of its present operations. The system includes covered wharves, and a commodious steamer of the ferry-boat class, connecting the city with the shore at Mount Pleasant, on the opposite side of the harbor. From this point 7 miles of electric railway, well constructed and equipped, carry passengers over trestle-work to Sullivan's Island, up the length of which it crosses Breach Inlet over to Long Island, and thence northward to the Isle of Palms, about a mile and a half distant, where there is an excellent beach and well constructed buildings for the convenience and comfort of health and pleasure seekers. The objects of the promoters have been to establish a resort suitable for both summer and winter visitors. The wharves, cars, boats, and buildings are all lighted by electricity.

SELECTED FORMULÆ.

Parlor Match Composition.—For parlor matches dry the splints and immerse the ends in melted stearine. Then dip in following mixture and dry:

Phosphorus (red)	3 parts.
Gum arabic or tragacanth	0·5 "
Water	3 "
Sand (finely ground)	2 "
Lead binoxide	2 "

Perfume by dipping in a solution of benzoic acid.

Shaving Soaps.—The properties most essential to a good shaving soap are softness, economy in use, and the power of retaining a lather for the longest possible time. We may distinguish between shaving soaps properly so called, shaving pastes, and shaving solutions, and proceed to give receipts for each.

SHAVING SOAP.

Purified tallow	90 pounds.
Cocoanut oil (first quality)	10 "
Soda lye	80 "
Potash lye	20 "
Color and scent to taste.	

Most shaving soaps contain cocoanut oil, as this fat is particularly efficacious in making them lather well.

SHAVING PASTE.

Soap	10 pounds.
Alcohol	1 ounce.
Oil of bitter almonds	1¼ "
Oil of bergamot	¾ "
Oil of mace	½ "
Oil of cloves	½ "

Melt the soap with just enough water to convert it into a soft paste when cold. The paste is then well rubbed up in a marble mortar, or passed several times through a kneading machine. This treatment is necessary, in order to impart to the soap that fine pearly appearance so much esteemed by consumers of this class of article.

SHAVING LIQUID.

White soap	10 pounds.
Alcohol	20 "
Orange flower water	30 "

Melt up the soap with some of the orange flower water at as low a temperature as possible, and when complete solution has taken place, add the rest of the orange flower water and the alcohol. After the finished product has stood for a few hours in a closed vessel it is bottled. Some makers filter the solution, but if very pure materials are taken, and if the solution is allowed to stand and deposit any insoluble matter as we have just recommended, the filtration, which is a long and tedious process, will become quite unnecessary.

Another recipe for shaving liquid is as follows:

White soap	12 pounds.
Essence of fat almonds	1¼ "
Alcohol	6 "
Rose water	6 "
Tincture of amber	2 "
Tincture of benzoin	2 "

The manipulation is the same as that described above. The soap may be dyed pink with alkanet or cochineal tincture.

To combine all the properties enumerated above, many makers who make a specialty of shaving soaps prepare them at a boiling heat. The following recipe will, however, give good results at low temperature, if the proportions given and the processes described are closely adhered to:

Melt together 200 pounds of tallow and 50 pounds of cocoanut oil, and as soon as the mass is sufficiently liquid, add 40 pounds of potash lye (30° Be.) and 100 pounds soda lye (30° Be.) When the soap is thick enough to pour, scent with oil of kümmel, 1 pound; oil of lavender, 1 pound; oil of thyme (white), ⅛ pound; fennel oil, ¼ pound.

SHAVING WINDSOR SOAP.

Melt together 400 pounds of tallow and 200 pounds of cocoanut oil. When the temperature is 100° F., stir in a mixture of 340 pounds of soda lye (34° Be.) and 60 pounds of potash lye (30° Be.) When the soap will scum in spite of stirring, it is ready for pouring, and this is generally the case in about twenty minutes. Scent with oil of kümmel, 3 pounds; lavender oil, 2½ pounds; and oil of thyme (white), 2 pounds.

YELLOW WINDSOR SOAP.

Treat as above, and at the same temperature, 250 pounds of tallow, 150 pounds of cocoanut oil, 100 pounds of palm oil, and 250 pounds of lye at 37° Be. Scent with oil of lavender, 5 pounds; oil of kümmel, 2½ pounds; oil of thyme, 1 pound; and oil of peppermint, 1 pound. If the soap is wanted darker, color with Uranium orange.

Another recipe for shaving Windsor soap, only differing in the scenting, is as follows:

Very pure white tallow	33 pounds.
Cocoanut oil (first quality)	16 "
Soda lye (30° Be.)	28 "
Potash lye (30° Be.)	5 "

Scent a few minutes after pouring with essence of caraway, 2½ ounces; essence of bergamot, 3¾ ounces; essence of Portugal, ½ ounce; essence of cloves, ⅛ ounce; essence of lavender, 1⅓ ounces; and essence of thyme, 1¼ ounces. After the soap is set, cut it up, dry the pieces, and rub with a very dry cloth, to remove any adherent dust.

MILITARY SHAVING SOAP.

Under this name, a molten palm soap of very agreeable smell is sold. Five hundred pounds or palm oil soap are melted as above, colored with coloring, and scented with:

Oil of cinnamon	1 pound.
Oil of kümmel	1½ "
Oil of lavender	1½ "
Oil of thyme	1 "
Oil of peppermint	½ "
Oil of bergamot	2 "

The soap smells especially good when dry.—Soap-maker and Perfumer.

THE PALATINE HILL OF ROME.

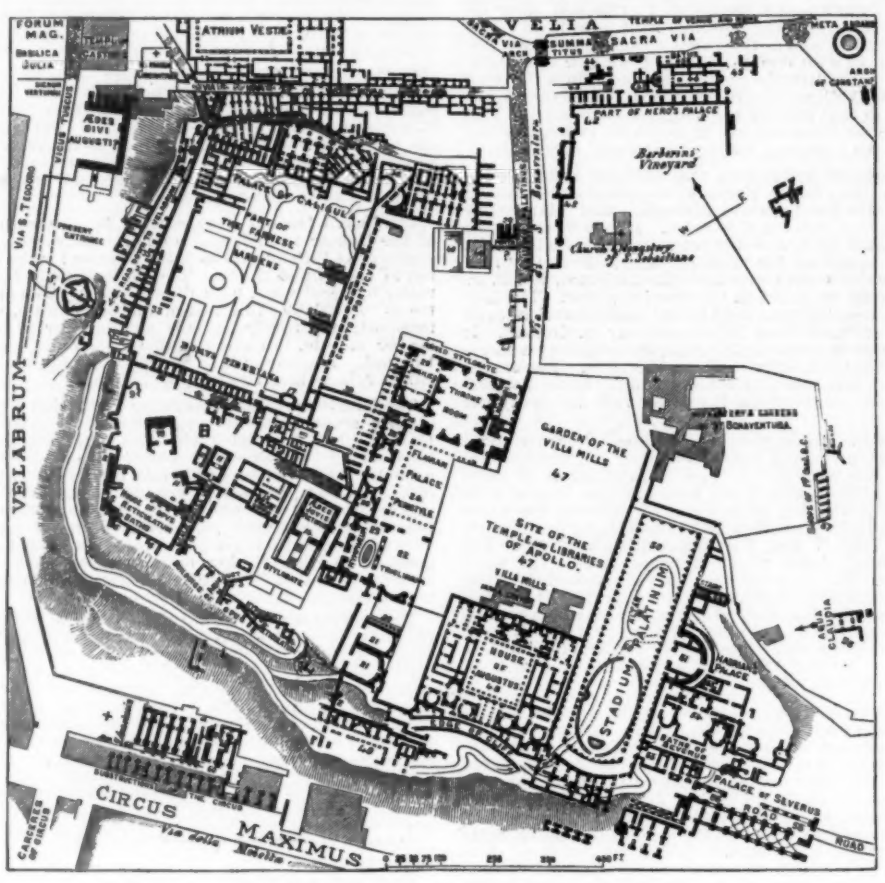
THE Palatine Hill is one of the hills of ancient Rome, and is situated on the south side of the Forum. It rises in the form of an irregular quadrangle, and is about 1,960 yards in circuit. Like the Captoline Hill, it consisted originally of two summits of almost equal height, separated by a saddle or depression; however, building operations have materially changed its appearance. Tradition places upon this hill the dwellings of its heroes before the foundation of the city. The Palatine was the original site and center of the small village of Roma Quadrata, and fragments of this primitive collection of huts, which was the germ of the great city which was to be the mistress of the world, have been found on the Palatine. In the republican period, it was occupied by private dwellings. Augustus was born on the Palatine, and, after the battle of Actium, he transferred his residence to this city of the ancient kings. His buildings covered a considerable portion of the south side of the hill; they included, besides the palace proper, a large Temple of Apollo, and a Greek and Latin library. The Emperor Tiberius built another palace on the north side of the hill, perhaps near his ancestral house. The Palatine Hill did not afford sufficient scope for the senseless extravagance of Nero, who built himself "The Golden House," extending from the Palatine to the Esquiline. The emperors of the Flavian dynasty once more transferred the imperial residence to the Palatine, enlarging and adorning the buildings of Augustus. The Stadium was erected at a later period, possibly by Hadrian. Septimius Severus extended the imperial abode to the south, beyond the limits of the hill. The Palatine suffered with the general decline of the city. It was inhabited by Odoacer and Theodoric, but from the tenth century onward the ruins were occupied by monasteries, fortified towers and gardens. The first excavations were made in 1726. The Emperor of Russia made another series of excavations in 1848, and in 1857 the ground came into the possession of the city.

In 1861 Napoleon III. bought the Farnese Gardens, and the work of excavation has been continued by the Italian government. Many interesting topographical discoveries have been made, although few works of art have been found. The Illustrirte Zeitung of recent date had a number of interesting illustrations of the Palatine which we reproduce.

Not all of the hills have been explored as yet, owing to the fact that there are two convents that still have possession of part of the hill. The intricacies of the topography of the Palatine are very great, so that the ruins are very hard to study so as to obtain a view of the buildings as they existed in their entirety. It must be remembered that a large number of the ruins as they exist to-day were simply substructures upon which the palaces were raised, their function being to make level the undulating surface of the hill, as is the case with the Palace of Severus, of which we show engravings.

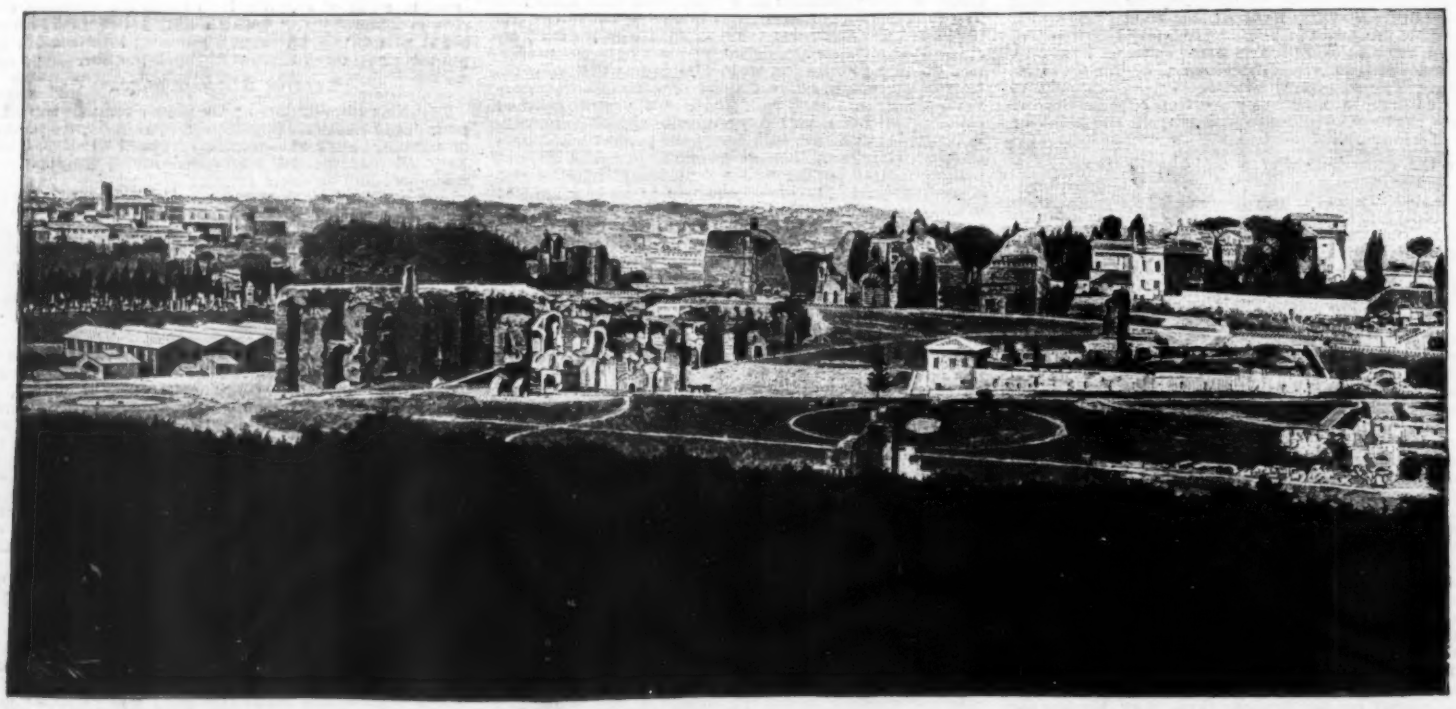
The ancient city occupied the platform of the hill, and it was protected on every side by precipitous banks and by rivers. In the upper left hand corner of our diagram will be noted the Temple of Augustus, erected in honor of the deified founder of the empire. The temple is particularly notable in connection with Caligula's Bridge, which is supposed to have crossed at the valley of the Forum, so as to enable that monarch to walk on a level from his palace to the Temple of Jupiter on the Capitoline Hill. Strictly speaking, there was no bridge, the Emperor passing from roof to roof of the intermediate buildings, which were bridged where streets were crowded with temporary bridges or gangways. This is shown at 37 in our plan.

It should be remembered that each Emperor to some extent enlarged, altered, destroyed and reconstructed the work of his predecessors, building new substructures, cutting new openings, walling up old ways, thus subdividing large rooms into smaller apartments and changing their uses. We will now make a circuit of the Palatine, beginning with the oldest remains. At 2 on the plan, at the extreme left, will be seen the remains of the early fortifications of the Roma Quadrata. The walls are composed of large blocks of tufa, 2 feet high and from 4 to 6 feet long. It is now generally admitted that they are a part of the earliest fortifications of the Palatine. The thickness of the walls is about 4½ feet, except at the angles, where they are 14 feet thick; their height does not exceed 13 feet, but they are supposed to have been 40 feet high. Behind these remains is a very ancient reservoir for keeping water in the fort, and there are some openings or shafts for letting down buckets. At 49 in the plan will be found the Domus Gelotiana; the walls of the rooms are very interesting, being covered with graffiti, showing that the place was occupied by veteran troops and frequented by boys belonging to the school of pages. The records scratched on the places by the scholars are highly interesting from an archæological and historical



MAP OF THE PALATINE HILL, ROME.

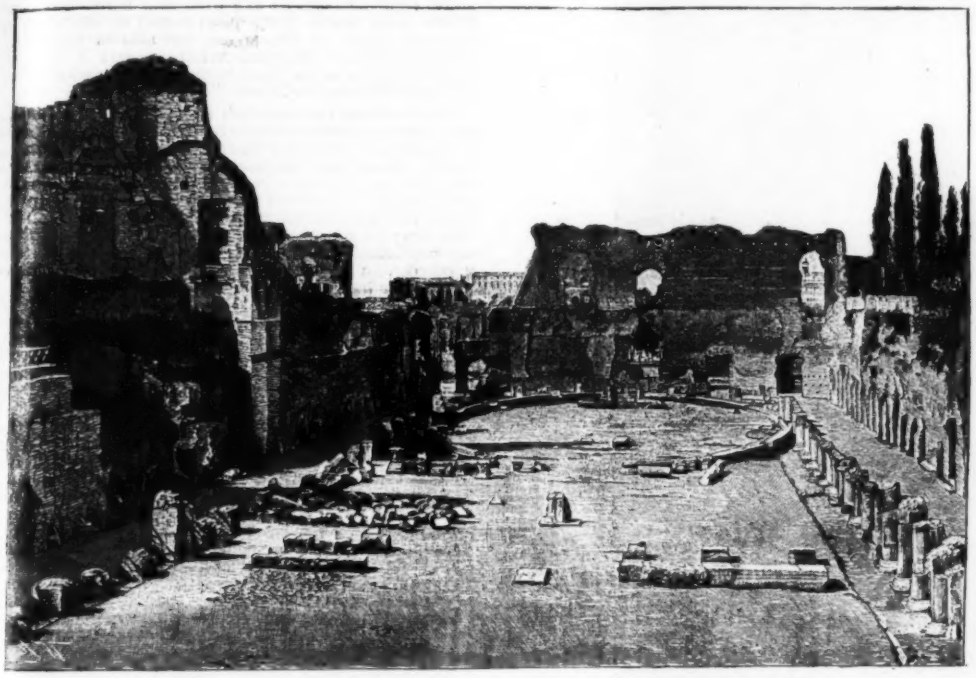
point of view. In this range of buildings was found the famous graffito which was long regarded as a caricature of the Christian Alexamenos, usually known as "Alexamenos Adores His God," in which he is in the act of worshiping the Saviour, who is represented as a man with the head of an ass, hanging from the cross. This is believed to have been the earliest representation of the Crucifixion, the one discovered a year or two ago having not been entirely accepted as representing the Crucifixion. Other investigators complain that instead of worshiping Christ, it is only a gnostic worshiping his jackal-headed deity. At 5 is the Scalæ Caci, which is an entrance of the primitive wall of Roma Quadrata. It is not a chariot road but a long flight of steps cut in the tufa like the rest of the wall of Romulus. At 14 is the so-called Temple of Jupiter Victor. The real dedication of it is doubtful. It stands on a lofty platform of tufa rock, artificially leveled, and occupies a most commanding position. In front of it were a flight of steps and two broad terraces; only very meager remains now exist. A short distance from this temple, at 18, is the "House of Germanicus," or the "House of Livia." It is very well preserved and is a complete specimen of a Roman house at the time of Augustus. It is constructed of tufa concreted with a neat facing of inserted stones, giving the so-called face of "*opus reticulatum*." It is divided into two portions, the state apartments and the private dwelling rooms. The state apartments consist of a vestibule which opened on the public street and subsequently on the cryptoporticus of the "Domus Tiberiana;" the other apartments were the triclinium, tablinium, etc., and bedrooms and private apartments are found behind, at the higher level of the hill. The paintings on the walls of the rooms opening into the atrium are found well preserved, being samples of Roman wall painting earlier in date that most at Pompeii and equal in execution to the best of them. Some of the lead water pipes are still found in situ. The pipes were joined in lengths of about 10 feet by an enlarged socket being formed in one end by beating it over a wooden conical core, while the other part was constructed by hammering so as to slip into the enlarged part, and then the two ends were soldered together. The House or Palace of Augustus is shown at 48. It



THE NEW PROMENADE ON THE PALATINE HILL VIEWED FROM THE TOWER OF THE CHURCH OF SANTI GIOVANNI E PAOLO.

was discovered in 1777; the front of the palace overlooked the circus and the Aventine and had ten windows besides the central door. The inner peristylium was 105 feet long and 90 feet wide. It was ornamented with 56 pillars of the Ionic order. The building must have been superb, but unfortunately the remains are very scanty.

The Stadium is shown in our engraving and also at 50 in our diagram and occupies the south side of the leveled plateau. It is a circus-like building about 625 feet long and 155 feet wide, and separated the house of Augustus from the Baths of Severus. It was built by Domitian and was enlarged and restored by Hadrian



LOOKING DOWN UPON THE STADIUM.

and Septimius Severus. The Imperial Tribune occupied the point marked 51 in our diagram. This Tribune opens in the middle of the south wall and was added by Hadrian; it is divided into two floors. The Tribune itself was on the upper floor and was ornamented with beautiful pillars of marble and red granite. The niches of the cycle contained statues of amazons. There seems to be considerable doubt as to the function of the so-called Stadium. Prof. Marx, quoted by Lanciani, considers that the name is wrong and that the place was a garden attached to the house of Augustus.

Various emperors tried to keep the Stadium in repair, and even as late as Theodoric, attempts were made to buttress the walls. He seems to have also transformed the plan and destination of the building. The arena, once possibly used for athletic sports, or, perhaps, for flower beds, was then occupied by a large oval basin. It may have been for a small amphitheater; this is shown in our engraving, which also shows the curved end fragments of the pillars of the portico. In the upper left hand corner will be noted the Roman method of throwing up walls of brick and tufa to immense heights by putting in arches at intervals. The Stadium furnished an excellent quarry of building materials during the middle ages.

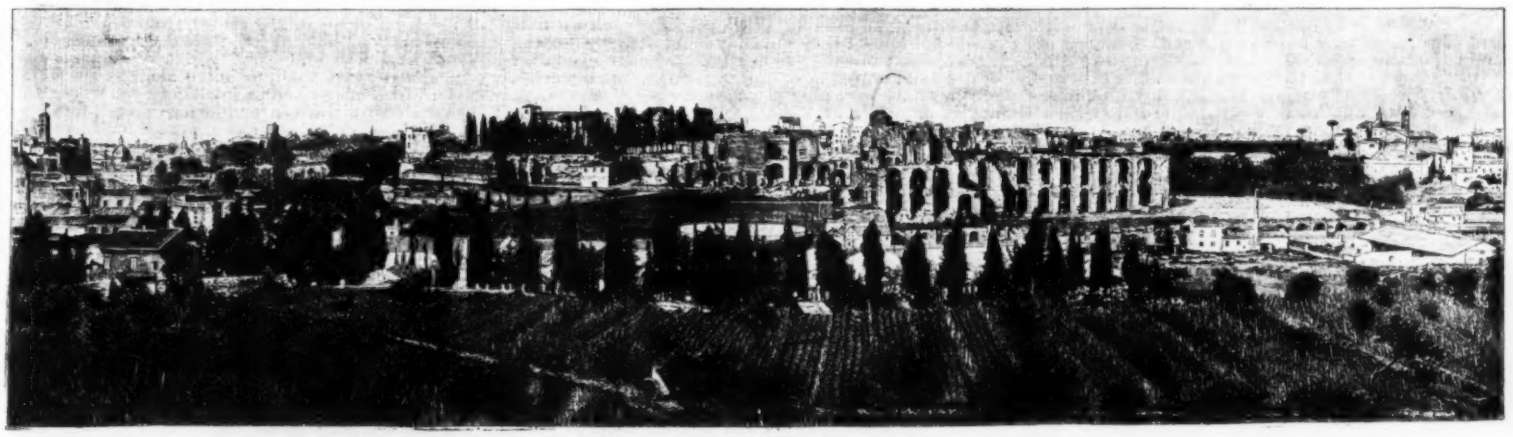
We now approach the Palace of Severus (55 in plan), of which we present two engravings. The remains have been very hardly treated by man and by time, and only the immense substructures remain. During the middle ages the monks who held the property rented them out for various purposes, and the practice appears to have been kept up, for Lanciani notes that as late as 1862 they were used for the storage of hay, and a terrific fire occurred in that year which burned 1,000 bales of hay and threatened to destroy the whole mass of buildings. The methods of heating by hypocausts and walls covered with flue-tiles may well be studied here, and the remains show the enormous strength possessed by Roman concrete and the freedom with which they used it.

Travertine corbels were built in at the springing of the arches; these were to support the wooden centering or framework on which the semi-fluid concrete was cast into the required form of arches and vaults, and have the double advantage of doing away with lofty wooden scaffoldings to support the original centering and of making future repairs economical.

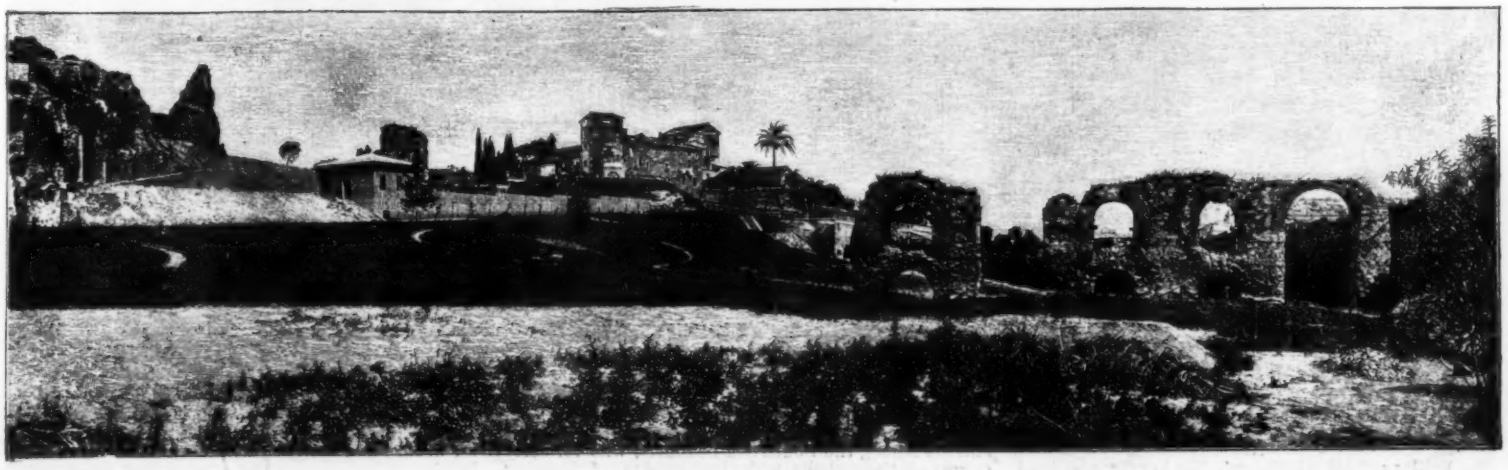
Parts of the Palace of Hadrian are seen at 53. Most of the building has been destroyed, but it has furnished many rich fragments of architectural decoration. The substructures of the Palace of Severus destroyed many of the rooms. Parts of the Claudian aqueduct are shown at 56 and also in the engraving. A series of storage cisterns was provided. These cisterns were arranged at different levels with communicating openings, so as to overflow from one to the other, and were made to supply different parts of the lower rooms of the Palace of Severus. At 57 are Roman shops of the first century A. D.

Having skirted the ruins of the western and southern sides of the Palatine, we will next take up the Flavian Palace, 21 to 29 on the plan. The enormous theft of land from the Roman people by Nero for building his "Golden House" was atoned for by the politic Vespasian and Titus, who destroyed the sumptuous palace of Nero and devoted a great part of its site to the pleasures of the people by building the Colosseum and the Baths of Titus on the Esquiline. After he destroyed the "Golden House of Nero," the Emperor Titus began to build a palace on the Palatine Hill; this is usually known as the Flavian Palace. The great building of Domitian contains no private rooms or domestic offices and was merely a vast series of state apartments, and was an adjunct to the earlier palaces which the emperors continued to use for all private purposes. The construction of the new palace caused important changes to be made in the contour of the Hill. It was raised on a large and lofty platform. The palace consisted of a large open peristyle, and around it are grouped the various public rooms of which the palace consisted. Imported granites and marbles were freely used all through the building, and specimens of the pavement and marbles which have been obtained are among the most beautiful which have come down to us. Probably the most interesting room is the nymphæum, a room completely lined with various kinds of marble, native and foreign, with niches for statues, while in the center was a large water basin into which jets poured from the central raised part. Aquatic plants and flowers in pots were set among statues; large windows opened from the triclinium, 22, into the nymphæum, so that the banqueters would be cooled and refreshed by the splash of the falling water and the scent of the flowers. The throne room was the most magnificent of all. A considerable portion of the middle part of the Palatine has not as yet been explored; portions of Nero's Palace may be seen at 42, but only substructures remain. The Temple of Jupiter Stator, which is of considerable historical importance, is seen at 40.

We have now reached the enormous collection of buildings which entirely cover the side of the Palatine which overlooks the Forum. They consist very largely of the substructures of the Palace of Caligula. The original contour of the hill was very much cut away and altered in form by this gigantic building, which spread out, not only over a large space on the top of the hill, but also over the sacred Grove of Vesta, and the ground once occupied by the houses of Clodius, Cicero, and other wealthy Romans. The whole building must have reached the astonishing height of over 120 feet and possibly a good deal more. The various substructures at different levels are connected by



THE PALATINE HILL AS SEEN FROM THE AVENTINE.



THE CLAUDIAN AQUEDUCT.

numerous staircases, so that it is almost impossible to make out the precise uses of a great many of the rooms that now exist. The ruins are particularly valuable as showing all the best forms of Roman construction. In the cryptoproticus, No. 31 in the plan, it is probable that Caligula was murdered. It is nearly 400 feet long

SUBSTRUCTURES OF THE PALACE OF SEVERUS.

and runs to the house supposed to be that of Germanicus.

The Palatine is the property of the Italian government and excavations have been regularly carried on, and in time the nation will undoubtedly possess all of the real estate, so that the entire hill will be explored. It requires at least two days to make anything like a satisfactory examination of the Palatine and at least a week must be spent in making a thorough examination of this most interesting collection of ruins of imperial Rome.

To Drill or Turn Aluminum.—Use kerosene oil (coal oil) for drilling or turning aluminum.

ENGRAVED SHELLS.

IT seems hardly credible that prehistoric artists should have left us works of art engraved upon a medium so fragile and difficult to manipulate as polished shell. Yet we find among the earliest of Egyptian and Chaldean relics large shells skillfully and elaborately engraved with representations of men and animals. What tools were employed by these primitive artists we do not know; they certainly had not finely pointed steel burins; but they evidently found sharpened flint or obsidian, or, perhaps, bronze needles, equally good, for they have been able to trace a variety of curves and angles requiring great care and skill without any apparent slip of the graving tool.

Shell gorgets, plain or engraved, seem to have been much worn as ornaments in prehistoric times, as they still are among the South Sea Islanders, who formerly engraved their shells with implements of bone or sharks' teeth, but now probably use broken glass or iron nails, procured from passing vessels, but they do not produce the elaborate designs of ancient Egypt. It is, however, in ancient America that we find the most numerous engravings on shell, some of which are as elaborate and full of detail as those of Egypt and Chaldea, while others are of extreme primitive rudeness. The most curious and archaic of these are masks, made of a large univalve shell, upon which the human face is rudely depicted; in some the eyes only are indicated by two holes bored in position, in others the shell is cut away to form a nose, and a hole is made for the mouth. Then we see circles drawn round the eyes, and tattoo or tear marks traced from them in zigzags down each cheek, while in some there is a further tattoo mark from the eye to the nose and across the chin. These shell masks have been found on skeletons in mounds, chiefly in Tennessee, but also in Kentucky, Virginia, Illinois, Missouri, Arkansas, and New York, those from the latter State being of a somewhat different type and smaller in size.

Next to these curious shell masks may be noticed a number of gorgets of somewhat similar form, engraved with the most uncouth figures, and bored with many holes. These are supposed to represent the human form, but it requires a very considerable stretch of the imagination to discover head and arms and legs in the contorted, convoluted figures traced upon these shells, which would seem rather to represent some mythological monstrosity, although the hands are distinctly marked with curved thumbs. More easily defined, although far from clear, is the representation of the rattlesnake, which may always be distinguished by an exaggerated rattle in some part of the engraving. In contrast to these rudely carved specimens, we find bold representations of spiders, which are unmistakable, and of the heads of birds combined with a square emblem, and usually with a cross in the center, the cross likewise appearing on the backs of the spiders. All these are still religious symbols among the Red Indians, and doubtless have been so for many centuries. The Spanish priests, on their first arrival in America, were astonished to find the cross already in use as a holy symbol, but it seems to have been employed in ancient Mexico, and among most of the northern tribes, as symbolizing the cardinal points, which, with the winds blowing from them, are still highly reverenced and have special colors assigned to them. Hence the crosses now set up in the great religious and healing ceremonies of the Ojibwas are cut square at the base and painted in four colors—white on the eastern side, green toward the south, red toward the west, and black toward the north.

The square, with twisted corners, signifies the concentrated winds in Navajo symbolism, while birds, spiders, and rattlesnakes are not only totems of powerful tribes, but have many legends attached to them among several of the Indian peoples. With the Cherokees, the spider is revered as having brought fire to mankind. The engraved shells denominated Runtees are large, flat, circular beads, with two holes bored through the thickness of the shell, leaving the surface free for ornamentation, which usually consists of a row of circles with a dot in each round the disk and a cross of the same dotted circles in the center. Schoolcraft looks upon these as badges of honor, and describes them as consisting of a "circular piece of flat shell, from one and a half to two inches in diameter, quartered with double lines, having the devices of dots between them, and doubly perforated in the plane of the circle."

Still more remarkable are objects known as scalloped shell disks found upon the breasts of skeletons in some ancient graves; these are all of one pattern, consisting of a dotted circle in the center, from which three or sometimes four volutes are drawn, surrounded by a plain circular band, beyond which is a broader band ornamented with eight or more double circles, between which are numerous small dots, the whole being surrounded by thirteen or fourteen bosses, forming a scalloped border. Two holes are made for suspension, and one at least of these gorgets has been painted red. The design resembles exactly that to be seen on Japanese drums, and the central volutes are such as are used in many countries as a sun symbol, and which may be seen on some of our ancient churches. American anti-

THE PALACE OF SEVERUS ON THE PALATINE HILL.

quaries look upon these disks as of the nature of calendars.

Still more elaborately engraved shells have been found in some of the American mounds, some of which may fairly compare with the Egyptian and Chaldean specimens. The most beautiful of the American examples is, unfortunately, imperfect, but evidently represents two winged figures with gryphons' claws instead of feet, contending for some object. They are apparently exact counterparts, and each holds what appears to be a curved pointed weapon in one hand and a short doubly pointed staff in the other, but the heads of both have disappeared, and the whole, when found in the McMahon mound, was in such a decayed state as to necessitate immersion in glue before it could be removed; when entire, it was nearly five inches in diameter.—Leisure Hour.

EXPORTS OF AMERICAN FURNITURE.

THE United States were for many years a market for foreign-made furniture, especially of the higher and more expensive grades. Mahogany tables, sideboards and cabinets, and furniture of rosewood and ebony, particularly desks and tables, were familiar articles of supply, coming chiefly from England and France. In the cheaper lines of furniture the American market was supplied with American-made products, but the importations were considerable and grew year by year until the enormous development of America's product of factory-made furniture completely transformed the situation.

By the last Treasury report, the total importations into the United States of cabinet ware and house furnishings collectively amounted to only $275,000, and the year previous it was about the same, while the total value of American-made furniture is now in excess of $100,000,000 a year. The three chief cities in furniture manufacture are New York, Chicago, and Grand Rapids, and the business of the latter, which had by the last Federal census 31 furniture factories and has still a greater number now, has been steadily increasing. There are in all the United States nearly 1,500 furniture factories, distributed throughout nearly all the States; but relatively few of them are in the Southern States, from which some of the most desirable wood for furniture comes. An exception to this general rule is Georgia, in which Atlanta and Macon have furniture factories that turn out considerable work. The superiority of Michigan woods for furniture making has secured the establishment of a number of factories in cities of that State besides Grand Rapids, Saginaw and Muskegon among them. The Pacific Coast States are coming competitors in this field, too, Washington and California having wood of the desired quality and in almost inexhaustible quantities for furniture making.

Along with the increase in the home manufacture of furniture for the American market, there has been developed an extensive foreign trade in American furniture, completely changing what was the rule up to a few years ago of the excess of imports over exports in this article of commerce. Last year the exportations of American furniture to foreign countries were to the value of $3,700,000, and it is a curious fact that the country to which the largest quantity went, exclusive of England and Canada, was Africa. The exportations of American-made furniture to Africa, notwithstanding the current belief that the household furnishings of native Africans are about as meager as their everyday clothing is sparse, amounted to $343,000. To Australia, American furniture to the value of $185,000 was sent; to Asia, exclusive of China, Japan, and India, $147 000; to the Argentine Republic, $62,000; to Mexico, $157,000; to Cuba, $35,000; to Porto Rico, $6,000; to the other West Indian Islands, $125,000; to Brazil, $36,000; to China, $21,000; to India, $18,000; to Japan, $27,000; to the United States of Colombia, $33,000; to Canada, $523,000; and to England, $1,027,000. The other European countries did not take much American-made furniture, though there were exports to France to the value of $234,000, and to Germany to the value of $315,000. A still larger market for American furniture would seem now to be probable, for its quality is constantly being improved, and there is at the same time a lowering in prices, and these two considerations point to increasing trade, even apart from the evident expansion of all American markets.

BEDS OF THE VARIOUS NATIONS.

IN England the old four-poster bedstead is still the pride of the nation, but the iron or brass bedstead is beating it out of the field. The English beds are the largest beds in the world. A peculiarity of the German is its shortness; besides that, it consists frequently in part of a large down pillow or upper mattress, which spreads over the person and usually answers the purpose of all the other ordinary bed-clothing combined. In the tropics men sleep in hammocks or upon mats or grass. The East Indian unrolls his light, portable charpoy or mattress, which in the early morning is again rolled together and carried away by him. The Japanese lie upon matting, with a stiff, uncomfortable wooden neck rest. The Chinese use low bedsteads, often elaborately carved, and supporting only mats or coverlids. The ancient Greeks and Romans had their beds supported on frames, but not flat like ours. The Egyptians had a couch of peculiar shape, more like an old-fashioned easy chair, with hollow back and seat. —The Sanitarian.

The results of an investigation by M. Considère to ascertain the value of metallic cores for strengthening mortar and concrete have recently been published. M. Considère, says The Builder, has arrived at the conclusion that mortar armed with an iron core can undergo without rupture an elongation twenty times as great as would be possible without the aid of a core. Tests were made with various mortars and concretes, using prisms of square section 60 cm. long and 6 cm. in the side, in which were embedded rods or wires of iron. M. Considère is of opinion that injury to buildings by the settling of foundations, unequal expansions, and shocks, is much less liable to occur when cores are used, and finds that wrought iron and hard steel of the kind used for rails is capable of strengthening mortar and concrete to a much greater extent than is the iron usually employed for cores.

[Continued from SUPPLEMENT, No. 1220, page 19553.]

WILSON'S PREHISTORIC ART.—II.

THE NEOLITHIC PERIOD.

IN our last issue we dealt with the Paleolithic period as treated by Professor Wilson in his "Prehistoric Art," and we now take up the Neolithic period, which was first discovered in Western Europe, although savages in that culture status in other parts of the world had been known long before. It, along with the Paleolithic period, is classed as part of the Stone Age, because the principal cutting instruments continued to be made of stone. There were radical differences between these two periods, differences in climate, geography, fauna, domesticity of animals, sociology, industry and art. We will not concern ourselves with these subjects, important though they are, but will proceed immediately to the consideration of the art of the two periods. In the Paleolithic period we have seen that a large number of sculptures were executed, and even a very crude form of painting was attempted; how nearly every animal belonging to that epoch from man down has been graphically represented in the fine arts of that period. On the contrary, in the Neolithic period there are innumerable specimens of decorative art as applied to industry, while we are wholly without graphic delineation of the animals of the period, and no attempt seems to have been made to represent any living thing or to make a representation of nature in any of its forms. The art of this period was entirely decorative and consists of marks, lines or dots, usually by incision in geometric form, such as hatch marks, zigzags, herringbones, chevrons, parallel lines and thumb marks. These decorations were principally employed in plastic art, and usually for the decoration of pottery. Graphic representations of this decoration show it to have been similar to that of the Paleolithic period, yet the likeness is more apparent than real. In Paleolithic times the decoration was principally by representations of objects taken from nature, and the

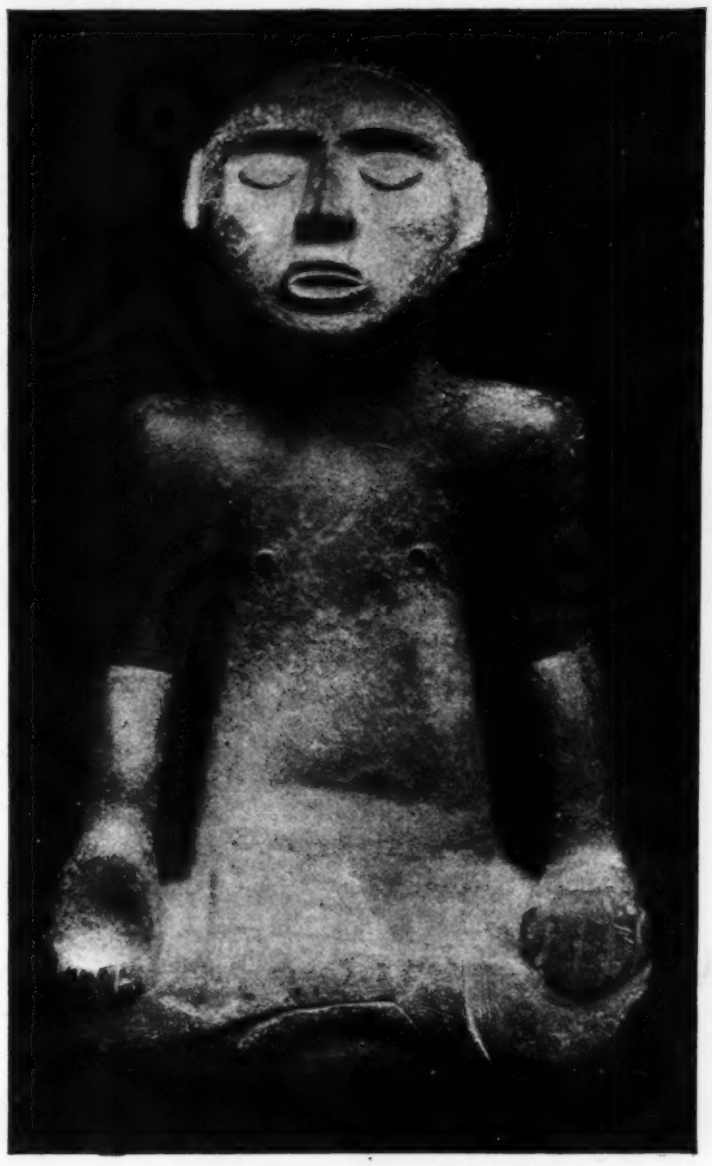


FIG. 1.—HUMAN FIGURE—STONE—GEORGIA.

FIG. 2.—STONE STATUE—FRONT VIEW.

FIG. 3.—STONE STATUE—SIDE VIEW.

geometric designs were used sparingly. Not so, however, in the Neolithic times. The designs, still geometric, were more complete, were larger, more extended, had greater continuity and were used a thousandfold more than in Paleolithic times.

The art of flint chipping was begun in the Paleolithic and continued until the Neolithic period. The fundamental distinction was that in the Neolithic period, after the preparation of flint instruments by chipping or battering and pecking, most of them were finished by the secondary process of grinding and in many cases polishing.

Prof. Wilson devotes a considerable amount of space and a wealth of illustration to this subject, which we can do no more than touch upon here. The engravings represent hammer stones, flakers, daggers, spear heads, implements of various kinds, polished stone hatchets, ceremonial objects, banner stones, gorgets, pendants, plummets, charms, etc. He then considers jade and hard stone objects, which were often beautifully polished and wrought by sawing and engraving, some of the most interesting being from Mexico and Central America, including jadeite masks, etc.

Aboriginal sculptures in North America are quite different from those of Europe. The Neolithic peoples of the United States were the North American Indians or their ancestors or predecessors, who made many pieces of sculpture in stone, wood, or pottery, representing animal as well as human faces and forms. Most of these were rude, though they sometimes presented the subject in a bold and marked manner. The sculptures in stone exhibited a skill in art inferior to that displayed in flint chipping, drilling, and polishing. The ordinary decoration of objects was not, as in Europe, confined to geometric designs. It appears as though the aboriginal American artist gave his fancy free rein, was not hampered by rules of art nor deterred from the most daring attempts by any imaginary mechanical or technical difficulties. This may be seen by our first engraving, which represents a human figure sculptured in stone. It is in perfect condition and was found near Stilesboro, Bartow County, Ga. It is 21¼ inches high and weighs 56 pounds. It is without a break of any kind. The figure is seated, and the legs are represented in the solid stone as though crossed, but in an impossible manner. The material is a fine-grained sandstone and the entire figure has been worked out of the solid rock. It has apparently been done altogether by battering or pecking into form and then rubbed or scraped smooth, and is not polished. The head rounds over the top of the skull, is broad across the middle, and the ears project. The eyes are oval; the nose is straight, the chin is short and rounded. The mode of treating the mouth is specially noted. The hands and arms are specially rude, the fingers being only indicated by scratches.

Prof. Wilson gives a number of other examples of stone figures, and our second and third engravings represent the front and side views of the stone statue from Etowah Mounds, Bartow County, Ga. The female figure is in a sitting posture, is 15¾ inches high and weighs 33½ pounds. It is cut out of a soft talcose rock and was originally of a grayish hue, and it now presents a ferruginous appearance. The ears are pierced, and the head is represented bald; there is a hole in the center of the head, which probably forms the socket

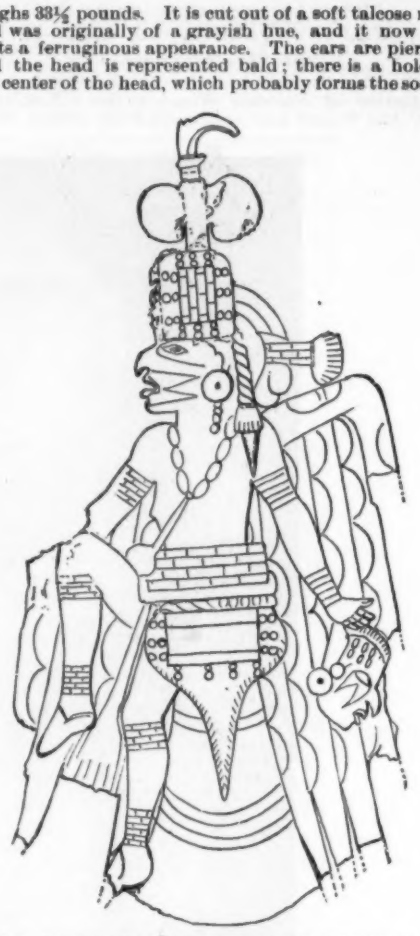


FIG. 7.—THIN COPPER PLATE FIGURE.

in which some head ornament was placed. Springing from the back of the head is a substantial handle by which this image could have been securely suspended or safely transported from place to place. The left arm was broken off, but otherwise this idol was in a state of remarkable preservation.

It was not only in stone that the native sculptors showed their skill, but also in pottery, and our fourth and fifth engravings give excellent examples of two head-shaped vases from Pecan Point, Ark. The fourth engraving represents a simple head five inches in height and five inches wide, ear to ear; the aperture of the vase is in the crown, and is surrounded by a low upright rim, slightly recurved; the cavity is roughly finished, and follows pretty closely the contour of the exterior surface, excepting the projecting features. The paste is yellowish gray in color and rather coarse in texture; the vase was modeled in the plain clay and permitted to harden before the devices were engraved. After this a thick film of fine yellowish gray clay was applied to the face, partly filling up the engraved lines. The remainder of the surface, including the lips, received a thick coat of dark red paint. The whole surface was then highly polished. The face cannot be said to have a single feature strongly characteristic of Indian physiognomy. We have, instead, the round forehead and projecting mouth of the African, says Prof. Holmes, who is quoted by Prof. Wilson. Our fifth engraving represents another head-shaped vase which closely resembles the one first described, but is not quite so well executed, the head not having such pronounced individuality. Prof. Wilson gives a large number of illustrations of interesting vases, pottery bowls, effigy bottles, etc. The section of Prof. Wilson's book on pottery, both here and in Europe, is one of the most interesting sections of his book.

THE BRONZE AGE.

There appears to be a gap or hiatus between the Paleolithic peoples and the Neolithic peoples in the occupation of western Europe. There were certainly vast distances between their respective cultures, and it has been believed that there was a solution of the continuity of occupation in western Europe between these two epochs. The contrary appears between the Neolithic and Bronze ages, at least for western Europe, where the introduction of bronze and its subsequent use for weapons and instruments seems to have occurred among the same people. The advent of bronze for these purposes was by immigration or introduction from some other country, and the peoples who used it this year were probably the same as used the stone implements the previous year. Therefore, the introduction of bronze, while it made changes in their implements, and so wrought changes in their mechanical abilities, yet had comparatively little influence upon their art. The discovery of the fusion of copper and tin, both comparatively soft metals, making a new metal harder than any other then known, capable of being cast, and, when cast, capable of being made sharp and holding a cutting edge, was a great step in human culture and calculated to revolutionize the destiny of the human race. The Bronze age had no existence in the western hemisphere during prehistoric times; all objects of bronze found among the aborigines are believed to have come from Europe.

Many objects of wrought copper have been found in America. The Lake Superior copper mines in the States of Wisconsin and Michigan appear to have been the center of manufacture, from which the distribution took place, and thence the manufactured implements spread in gradually decreasing numbers in

FIG. 4.—HEAD-SHAPED VASE.

FIG. 5.—HEAD-SHAPED VASE.

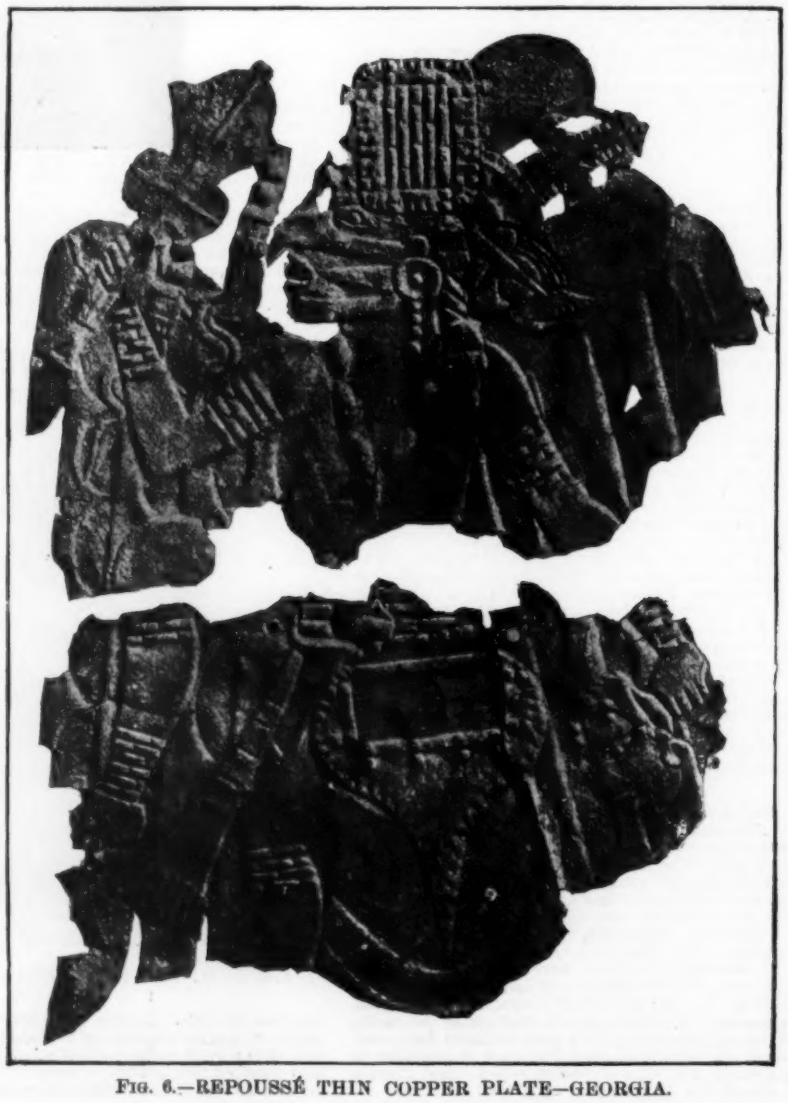


FIG. 6.—REPOUSSÉ THIN COPPER PLATE—GEORGIA.

every direction throughout the present territory of the eastern United States. The modes of treating copper, whether by smelting, melting, casting, or hammering, and if any or all of these, have never been fully investigated nor have they been satisfactorily determined. Some of these objects were certainly of native copper hammered cold, and they were thus made into bracelets, rings, and similar objects of personal adornment, and also into axes, knives, and spear-heads. Prof. Wilson is aware that there was in Europe a Copper age intermediate between the Neolithic and Bronze ages. The only proposition which he presents in his monograph is that copper was used in the neighborhood of Lake Superior to make cutting implements of similar form to those of stone, and that, despite the numbers of such implements found, copper did not change the culture of the people; it did not establish a Copper age as bronze established a Bronze age in Europe; it was not an epoch-making discovery or invention, and the mode of making and using stone implements by chipping and polishing was not superseded by the discovery of copper.

Among the many mysteries of prehistoric archæology growing out of mound excavations in the United States, wherein are found strange and wonderful things of undoubted genuineness and antiquity, none are more unexplained than the thin sheets of copper wrought by repoussé work into curious and unknown devices which are found in mounds and earthworks in widely separated regions of the country. We present (Fig. 6) an example of a thin repoussé copper plate of the human figure from Mound C, Etowah group, Georgia. The leading motive seems to be Mexican and Central American. Prof. Thomas thinks that these plates are not wholly the work of the Indians inhabiting the southern section of the United States, and he thinks it probable that they were made by an aboriginal artisan of Central America or Mexico of ante-Columbian times, if not from the designs themselves, from the apparent evidence that the work was done in part with hard metallic tools. To the latter conclusion Prof. Wilson does not agree; the proposition may be true, but there is no evidence of it. Other thinly wrought copper plates have been found in the interior States, notably Illinois and Ohio, and our seventh engraving represents another thin copper figure from the same mound. Our eighth engraving represents a copper head-dress with sprouting horns. It was found in the Hopewell mound of Ross County, Ohio. Strange to say, the head-dress was on wood horns carved to represent elk horns. The wood of the horns was entirely covered with thin sheet copper neatly and artistically placed, so as to have the appearance of solid copper, and the portions of the wooden horns are seen projecting through the top.

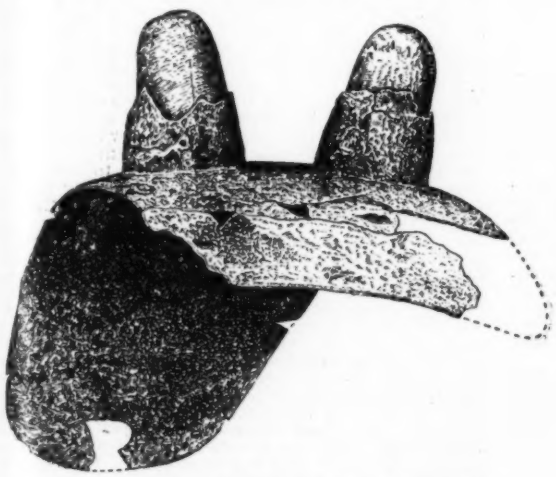


FIG. 8.—COPPER HEAD-DRESS WITH SPROUTING HORNS.

Prof. Wilson then takes up the use of gold and silver for adornment and gives some interesting examples of beautiful gold objects which formed at one time the jewelry of the savage people. Our ninth engraving represents a series of gold objects from Bogota, Colombia, South America, and shows to what a remarkable degree the natives of South America had attained in the goldsmith's art. The third and last section of Prof. Wilson's monograph is devoted to prehistoric musical instruments and occupies some 150 pages of "Prehistoric Art." We may at some future time review this special section of the book. We cannot close our somewhat lengthy review of Prof. Wilson's book without expressing our appreciation of the wonderful work which the Smithsonian Institution is doing in publishing a work of so much real importance as Wilson's "Prehistoric Art."

THE LOVE-GIFTS OF BIRDS.

APRIL and May are the chief months, says Charles A. Witchell in Knowledge, in which wild birds are nesting; and in these months the birds' small property is most heavily taxed by collectors. All but a minute fraction of this waste of egg-life is useless. But this is an old theme. The remark might be permitted, however, that in the treatment of wild birds the country should learn from the city, where public ornithology rises above the use of the gun, and knows how to tame as well as how to kill. It might be of benefit to the sportsman who goes to the seaside armed with a gun if he were to stand for five minutes on the Embankment, or on the bridge in Regent's Park to see the gulls fed.

It is proposed to treat of the restraint of a wild bird's impetuous voracity when it offers food to a courted companion or a brooding mate. The incident proves the bird to be akin to man in sense and feeling; and even the possession of ulna, radius, and metacarpals, will never prove that. It is not every animal that rises to so high a level as to share dinner with a mate; not all dogs, nor even all human beings, attain to it.

Of course, if adult birds of any species habitually fed each other on ordinary occasions, the same behavior in the breeding season would be no evidence that it had anything to do with love. But the converse is the case. I have never heard of a wild bird which habitually shares its food with a mate. In times of scarcity, however, a bird has sometimes been observed to feed a companion. In the severe winter of 1879–80 there was a good deal of snow in the western counties, and the rooks had a bad time, finding a diet of mangold insufficient. Several of them came to a garden in which the birds were fed. Another rook, whose flight betrayed its lightness and weakness, perched in a tree there, and one of the usual two or three took up a piece of bread directly to the newcomer, and gave it up to him without any show of resistance or anger. I saw this from a distance of about twenty-five yards. Quite possibly the birds were mates; but the incident is only mentioned for its rarity.

In the nesting season the males of many species feed their mate on or "off" the nest, as is well known. The rook, for instance, brings food to his mate, who, when receiving it, flutters her wings (a frequent habit at this time), and also utters a hoarse cry similar to the cries of the young. The adult rook utters this note on no other occasion. In several species of finches, also, the male feeds his sitting mate. I have seen this done by the chaffinch, greenfinch, linnet, and lesser redpole. The recipients shook their wings and uttered call-notes. The food thus bestowed could hardly be termed a "love-gift"; but when, before birds have a nest, and apparently before they have paired, the male gives the female morsels of food, it is fair to assume that this courtesy is intended as an earnest of passion—that it is, in fact, a love-gift.

FIG. 9.—GOLD OBJECTS.

I do not know of any book to which the student can refer for information on this fascinating theme. He should, therefore, refer to the book of nature; and if he will use a small telescope, and be silent, he should easily obtain information from this source.

Among the raptores, it is probable that the brooding female obtains food chiefly by the agency of her mate. Major C. Hawkins Fisher (the well-known falconer) informs me that the male peregrine hunts all day to supply the domestic larder, which is in the charge of his mate.

Among domestic birds, the common fowl affords a conspicuous instance of gallantry when the male calls the females to some choice morsel. He obviously intends the tid-bit only for the hens, and any rival attempting to partake of it is at once attacked.

In regard to domestic pigeons, I have obtained information from my brother, Mr. E. N. Witchell, who has been for many years a successful flier of homing pigeons, and has from childhood kept this and other varieties. One of the indications of pairing by pigeons is the insertion of the beak of the male into that of the female, and this is accompanied by a shuffling of the wings exactly as occurs when the young are fed. It does not appear, however, that any considerable amount of food (if any at all) passes from the male. Homers never omit this performance before pairing. The male homer is passionately fond of his home, his mate, and his young. But though his mate is a model wife, he is not a model husband, and often, especially if a strong flier, he is likely to bring domestic troubles into the life of any unmated young female bird in the loft. But it is a general rule for the cock to "feed" only his own hen, though there are exceptions to this rule. This very curious fact has often been noticed by my brother. It indicates that to the wife of the nest this courtesy of the pigeon is reserved, and that the other birds are deemed unworthy of it. These observations do not apply to pouters, runts, and trumpeters, which are "very immoral." It should be remembered that homers live the most naturally of any except farmhouse pigeons, and they may, therefore, be supposed to possess the natural instincts of their race in greater vigor than any other fancy breed.

Returning to wild birds, my opportunities have been too limited to enable me to generalize; but the following observations may be not without value to those who try to see in the bird a sentient and tender being.

A few days after the arrival of the spotted flycatcher, a pair of them were in a near tree. The male often attempted a song, and was evidently following the female. He suddenly went forth on a longer journey than usual, as though for a larger insect, turned and went to the female, and in the gentlest manner presented to her the captured insect (which appeared to be of the size of a bee). She took it sedately. Shortly after, she received another gift of the same kind. A second pair of flycatchers behaved in precisely the same manner. Last April a male robin gave some food in the same way to its mate. Both birds often uttered their call note.

Several male chaffinches, before nesting time, gave captured insects to their intended mates. All these insects were captured in flight. The chaffinches were full of ardor, the males, all a-flutter with excitement, following the females, and with the cuckoo-like flight, which is one of the bird's surest signs of love, and repeating the soft love-note almost incessantly.

On one of the first days of May, two willow wrens were busy in a hedge. The male often sang, but was mainly intent on keeping near his companion, who appeared to be a female bird. She was seemingly indifferent to his presence, and hunted for insects with all the graceful activity of her species. But she remained in the same spot. The male was greatly excited, his wings lowered and pulsating, and his call-note prolonged to a scream rather than a chirp. Through the telescope it was evident that she also was trembling a little. Suddenly the male darted forth, returned and alighted near the other. He then

without haste went to her, and her beak met his. The incident was so brief that the telescope could not be used; but it was, perhaps, fair to assume that he had found and bestowed a love-gift. She accepted it with the same sedateness that the female flycatchers, chaffinches, and robin had exhibited in the like circumstances.

CULTIVATION OF THE VANILLA BEAN IN MEXICO.

THE State of Veracruz has been considered the home of the vanilla, but recent developments show that vanilla can be cultivated in the State of Tobasco and on the Isthmus of Tehuantepec. The true home of the vanilla, where it flourishes best in its wild state, is a narrow strip about 30 miles wide, 5 miles back from the coast, and 90 miles long. The upper end of this strip is about 50 miles south of Tampico and extends along the coast 90 miles toward the city of Veracruz, the bottoms along the Tuxpan, Casonez, and Nautla Rivers and the creeks contiguous constituting the richer parts. Here the cultivated varieties yield most without artificial fecundation, either on account of the large number of wild bees in this locality or by self-pollination, which some claim is impossible. Artificial fecundation must be practiced in order to produce the beans in commercial quantities.

PLANTING THE VINE.

The vanilla plant is a vine of a light green color, with a smooth, waxy, transparent bark. It has a thick, waxy-looking leaf, light green in color, 6 to 9 inches long, 1¼ to 2 inches wide, and sharply pointed. The vine reaches out tendrils which cling tightly to its tree support, but do not, as some believe, draw nourishment from the tree.

The best time to set out the vines, or rather cuttings, is in April or May. The cuttings are the vines divided into lengths, usually 2½ to 3 feet long. Some of these can be cut in two according to the number of joints. Two or three joints are sufficient to put under the ground, with the same number of joints above ground. The plants are easy to propagate; in fact, they are hard to kill if kept from being bruised. A cutting can be kept in the house on a dry shelf, and it will live for months with scarcely any apparent change. Cuttings can be procured soon after the beans have been gathered, and usually sell for from $10 to $20 Mexican per thousand.

PREPARING A VANILLA PLANTATION.

Much depends upon the selection of location. The first thing is to have your plantation where one can prevent the pilfering of the beans while ripening. Enough can be carried away in a person's pockets to amount to more than a month's wages. The temptation is great, and often one does not harvest the fruit of his own labor; others do that for him, unless his vines are where a strict watch can be kept over them. Always select wild lands and clear out all the large trees. A vanilla plantation need not be large. A few acres, with care and proper fecundation, will soon produce a fortune. Patient care and attention at the proper time is the chief secret of success. For instance, if fecundating is not done in the proper way and at the proper hour of the day, the fruit is lost for that year. There are other peculiarities about the vine equally as essential to know, and success comes only with painstaking and patient care.

The vines require rich soil, heat, ventilation, shade, and moisture. Rich pockets of land along the creeks and river bottoms are best. A profusion of wild vines of all kinds growing into a jungle, with abundant loose soil affording ventilation at the roots, is the best proof of the adaptability of the land. Let the land be free from sand, on account of drought, and free from clay, which would cause the vines to rot during the rainy season. Let there be plenty of small trees at the feet of which the vines may be planted. Trees which have smooth bark, and which never shed their bark or leaves, which grow to be no larger than 2 to 4 inches in diameter and from 7 to 10 feet high, are best for this purpose. Usually, a variety of such grow on all wild lands and any of them are good, if the trunk of the tree be smooth, with plenty of sap. A small orange tree affords a good trunk for vanilla to grow to. If, while clearing the land, there be not enough of such trees found already growing to plant the desired number of vines (there should be from 1,500 to 2,000 vines to the acre), enough should be planted, selecting the kinds that make the most rapid growth, which exist in abundance and are destroyed by the thousands in nearly every new clearing of land.

The ground should be kept clean from weeds. All undergrowth should be thrown around the vines to decay, and serve as a mulch for the roots. The ground around the roots should not be disturbed. One or two vines should be planted to each tree and tied at first to the trunk with some flat, flexible band, such as strips of cocoanut leaves or plantain fiber. Round cord should not be used, as it is liable to cut and injure the green, succulent stem of the vine. Live stock should never be permitted on a vanilla plantation. The stem and roots of the vine should be disturbed as little as possible. The vine needs no cutting or pruning. All other wild vines should be cut out and kept from choking the vanilla vines. The trees should be topped to prevent too high a growth, so the flowers can be reached from the ground. Light and ventilation beneath, shade from the sun above, rest, and plenty of moisture—but free from standing surface water—are the prime requisites for the growth of vanilla vines.

DECAY AND RECUPERATION OF THE VINE.

One peculiarity of the vine is that after three or four years' planting, the stem will rot off at the roots and continue to rot 3 to 4 feet up the vine, while the top looks green and flourishing. In the meantime, from above where it is going to rot, it shoots out fine little rootlets like threads and continues them to the ground. So delicate are these threads running along the trunk of the tree, and so prominent the rotted-off end of the stem, that it gives the vine the appearance of living independent of the earth, giving rise to the theory that it is an air plant. It will sustain itself in a severed state; but to make material growth and fruitage, it must connect itself with Mother Earth.

YIELD.

The new vine will commence bearing the third year from planting, and full crops may be expected the fifth year. A vine will bear from fifteen to forty-five beans a year. I have seen as high as thirteen full-sized beans in one cluster, and frequently see clusters of nine. Some vines have been known to produce as high as sixty-five beans at one time. Twenty beans to a vine is a good average.

A green bean is worth from 8 to 14 cents at present in this market, or an average of 12 cents. In some years, the bean brings as high as 18 cents.

Rarely do those who grow the beans cure and market their crops. Others buy the green beans and make a business of curing and exporting them. Judging from the way they all get rich at the business and the difference between the price at which they buy the green bean and the price at which they sell the cured, there must be more profit in the curing than in the growing. Still, in view of the price of vanilla and the demand for it all over the world, there are large profits for both parties.

PRICE OF VANILLA LANDS.

Wild lands, suitable for vanilla, can be bought for from $5 to $10 per acre. There are vanilla-producing plantations in the vicinity of Papantla that could not be bought for $500 an acre. Various estimates are being furnished as to the cost per acre of converting wild lands into vanilla-producing plantations. Approximately, $85 an acre is correct, which is very moderate for so profitable a plant. To make a success in this industry, a man should move his family here, turn every member into workers at the proper time, then wait and make a living at something else for four years, until the first crop is gathered. They fail who try to make a vanilla plantation produce by the use of money alone.

HOW TO SUCCEED IN THE INDUSTRY.

The greater part of the vanilla in this consular district is grown about Papantla, much of which is exported from Veracruz, it being easier to reach Veracruz by water than Tuxpan by land. I do not regard Papantla any better for vanilla than the balance of the district that I have already outlined, the success being due to the colonists who settled there years ago—patient, industrious, hardworking French people, who came here poor, with large families, the women and children all turning out to help at the necessary seasons. The most of them have since grown rich. Some of them are now living in France, while others continue to make their homes in Mexico.

POLLINATING AND HARVESTING.

The two busy seasons of the year are during the pollination months—March, April, and May—and the gathering months—November, December, and part of January. During the balance of the year, the plantation should have absolute rest, other than keeping down the weeds and undergrowth.

Many of the beans are gathered in October, sometimes before they reach their growth, by those who see an opportunity of gathering them unknown to the owner, or by the owner for fear of losing them because he has not his vines where he can watch them. Beans gathered too soon are woody and inferior in quality, lacking the oil that furnishes the flavor. Good, ripe beans lose but little of their weight while curing; 5 pounds of green beans will weigh 4½ pounds when cured. The quality and flavor is increased by allowing them to mature and by proper curing.

The curing is principally done by Spaniards who have followed this business. The process adopted is slow and laborious. The secret is to evaporate the water, while retaining the oil, prevent the bean from molding, and not injure the flavor.

CONCLUDING REMARKS.

Neither space nor time will allow me to go into the many little details necessary in planting, growing, and curing. In this report I only describe the kind of lands necessary, the best location, the profits of the business, the necessary requirements for successful fruitage, and the causes of failure. Little details can be learned after getting here.

There are a few Americans already here in the business with plantations about ready to bear. Some have just started. Many others are coming, judging from the numerous inquiries. Heretofore, the French have mainly cultivated the vanilla, with now and then a Mexican, while the Indians hunt and gather the wild vanilla.

Vanilla is principally exported to the United States—about $2,000,000 worth per annum.

I write this article to answer in a general way the many inquiries addressed to me concerning this industry. Now that our people are embarking in it, I look for improved methods that will increase the production and simplify the process of curing.

A. B. JONES, Consul.

Tuxpan, January 30, 1899.

DOES THINKING OF A PART AFFECT ITS GROWTH?

"IT has long been a popular idea," says The Lancet, "that too much thinking about any particular part or organ may lead to disease of that portion of the body, but it must be confessed that very little substantial basis of fact has served as foundation for this superstructure. Dr. Carpenter was, we believe, the first to point out and to demonstrate by experiment that concentrating the mind on a special part of the body will lead to a local hyperæmia with sensations of tingling and itching, but, so far as we are aware, no true inflammation was ever produced. It is not difficult to understand that the directing of the mind toward some particular part of the organism may alter the blood-supply of that part and so may modify materially its nutrition. If this be possible—and who can say it is not?—it is not at all unlikely that morbid changes may result from, or be predisposed to by, these slight beginnings. It is very difficult, however, to find many cases which can only be explained satisfactorily by some such theory. Mr. W. H. Bennett, in a clinical lecture recently delivered at St. George's Hospital, quotes two cases which if not convincing are at least very suggestive. In each of them increased growth of a tumor appeared to follow the continued concentration of the patient's attention on the part. It has occasionally happened that a physician or surgeon who has paid particular attention to the diseases of some one organ or region of the body ultimately suffers from an affection of the same part. These cases, though striking, are but few in number and no more numerous than would be expected from the laws of probability. If there were any certain foundation for such an idea, medical men might be found to hesitate before 'specializing' on the more painful and unpleasant diseases to which the body is liable."

CARBON VAPOR IN THE SUN.

A DAINTY piece of spectroscopic work by Professor George E. Hale, director of the Yerkes Observatory, has recently come to light, says The New York Tribune, although it was performed several months ago. In the solar spectrum there were long ago recognized bands that indicated the presence of carbon. But whether that substance was in the sun's atmosphere or in the earth's, and, if the former supposition were correct, in what part of the immense gaseous envelope of the orb of day, no one dared to say with confidence.

It has been suggested, to be sure, that the dazzling brilliance of the sun is due to minute particles of solid carbon floating in that luminous cloud shell, the photosphere. But this theory, while having an air of probability, has not yet received substantial demonstration. Until Professor Hale took up the investigation, the nearest approach to evidence that there is carbon in the sun at all was the indefinite announcement, in reports of the eclipse of January, 1898, that in some of the photographs taken of spectra of the appendages of the sun, carbon bands had been detected.

What Professor Hale has done is to locate the carbon with precision, and thus to establish its existence beyond a doubt. One element of his success was the size of his new telescope. While he was still living in Chicago, and conducting now famous work at his private observatory, he had a twelve-inch refractor, which gave him an image, at the eyepiece, only two inches in diameter. But with the immense forty-inch refractor at Williams Bay he is able to get a seven-inch image. Setting the slit of his spectroscope on the very edge of that image, he was able to observe hundreds of lines, representing the gaseous layer known as the chromosphere, and lying just above the photosphere. Among these he found a considerable number that had never before been catalogued. But he also noticed that a certain shaded band, indicating carbon and situated near the "small b" line, was beautifully revealed. It was resolved into its component lines, spaced from each other in that wonderfully rhythmical manner that is still a puzzle to the expert physicist. The clearness with which these lines were defined had never before been approached.

A new and decisive experiment was now found to be feasible. By a slight change in adjustment the slit of the spectroscope was alternately made to cover the edge of the photosphere—what is to ordinary people the hard, substantial disk of the sun—and then the atmospheric layer just above it—something never seen without instrumental aid. This shifting of the instrument was attended with a curious change in the carbon lines. At one moment they were bright and at another they were dark.

Every spectroscopist knows that when an incandescent gas is viewed directly it gives a bright-line spectrum, and when another source of light is placed behind it, so as to allow a different radiance to shine through the layer of vapor, the lines will be dark. It was thus demonstrated that the carbon existed in the form of vapor in the chromospheric layer, and that when only this layer was covered by the slit of the spectroscope, bright lines were visible. But as soon as the slit was placed over the photosphere, the light of the latter, coming through the chromosphere, would produce black lines.

After having settled the fact that the carbon which produces the familiar markings is in the solar atmosphere, Professor Hale undertook to ascertain its exact position therein. He then found that it was in the lowest part of the chromosphere. When that particular envelope was in an undisturbed condition, the carbon came first, iron next and then sodium, magnesium, helium, calcium and hydrogen. But when an eruption occurred, tossing the chromosphere up into enormous billows and destroying all semblance of definite arrangement, the position was not well defined.

Professor Hale is satisfied that the carbon layer is a thin one, and that normally it lies down within five hundred miles of the sun's surface—a conclusion that harmonizes well with the notion that the glow of the photosphere emanates chiefly from particles of solid carbon suspended therein. For it is highly probable that the intense heat of the sun—estimated by some scientists at eight thousand degrees Centigrade—would vaporize a little of the carbon in the luminous cloud shell and send it up into the chromosphere.

It was only under the most favorable conditions of terrestrial atmosphere and other related factors that Professor Hale could make these observations. The delicacy of the work is shown by this fact. Measuring sizes and distances with a micrometer requires the utmost stability of apparatus and steadiness of atmosphere. Yet so firmly mounted is the immense refractor at Williams Bay, that Professor Barnard can perform this task while the driving clock is being wound. But when that operation was performed in the middle of Professor Hale's examination of the spectrum of the chromosphere, the carbon lines disappeared in an instant. It is possible that the great thirty-six inch glass of the Lick Observatory, in California, may be able to show these lines well defined; but with that exception it is not likely that any other telescope in the world will admit of an observation such as the talented young director of the Yerkes Observatory has been so slow in reporting.

Woolen Quilts and Mattresses.—The Iowa State Board of Health has found occasion to make strict regulations in regard to woolen quilts and mattresses made of old rags. It is found that these articles are made from the vilest materials, gatherings of ash barrels and refuse of all kinds, and the cheapness of the raw material permits their sale at such low rates as to give them a market. The danger to the public lies in the fact that some of the material may be infected with disease germs.

WAVE ACTION IN GUNS.

By FREDERICK H. McGAHIE.

THE regularity of action of smokeless powders has been made the question of the day in American ordnance circles by the destruction of a rifle during proof at Sandy Hook. The matter is now receiving a thorough examination by an investigating board, and all knowledge derived from past experience and theoretical investigation will be brought to bear upon this most important phase of propellants, for it is manifestly clear that the value of higher ballistics is negatived entirely if the powder or system employed is accompanied by a decrease in the safety given as compared with the one to be superseded. The facts of the explosion are these: A new 10 inch rifle was being proved by Dupont smokeless powder made in accordance with the Schüpphaus-Maxim patents. Other rifles of the same caliber and type had been successfully tested in the same manner, and the powder had acted normally. The powder consisted of short grains with seven longitudinal perforations, the formula being the standard army one of 75 per cent. nitrocellulose and 25 per cent. nitroglycerin. In the gun in question a charge of 141 pounds had been fired, giving a pressure of 32,000 pounds. This charge was increased a few pounds to obtain the service pressure of 35,000 pounds, the increase being calculated by the Sarrau formula, which has been used most satisfactorily the world over for many years. Disaster followed the command to fire. The breech block was blown off with velocity sufficient to make it penetrate the protecting butt directly in the rear of the gun and to kill the recorder of tests. The breech tube was knocked off. As to the condition of the powder chamber and the rest of the gun, nothing can be known definitely until the report of the investigating board appears. A recovered gage indicated a pressure of 70,000 pounds. These conditions show plainly that detonation did not occur, this explosive action being characterized by enormous pressures developed so suddenly that lines of least resistance are utterly ignored in the destructive effects accompanying it. Had the charge of smokeless powder detonated, the whole chamber would have been subjected to an impulsive blow, around 100 tons per square inch, that would have torn it off completely from the tube of the gun and projected it in various sized pieces over the proving grounds. I doubt if a bona-fide case of detonation of a gunpowder charge has ever been clearly established. It serves as an explanation of unknown or unestablished causes. Had the powder cracked up through excessive internal pressure, the sudden increase of burning surface provided by the fragments would have given rise to a dangerous jump in the pressure, which, reacting on the velocity of combustion of the powder, would have carried it still higher before the movement of the projectile had sufficiently increased the expansion volume. Too long a multiperforated or tubular grain will break up into a few, not many, pieces. But the short grains used were far within the limit, and many tons of such powder have been fired since 1894 without giving the slightest hint of such action. The firings were made in a wide range of guns, with wide variations of loading and ballistic conditions. The accident has been made the subject of several articles in recent numbers of the SCIENTIFIC AMERICAN and SCIENTIFIC AMERICAN SUPPLEMENT.

In the light of the above matter the theories advanced by Hiram S. Maxim appear absurd, if indeed the replies of Hudson Maxim do not reveal the nature of those letters as a vicious attack upon an excellent powder, based upon personal animosities.

The phenomenon that took place in the wrecked gun was undoubtedly that conforming in general to the theory advanced by Hudson Maxim in his letter in the SCIENTIFIC AMERICAN of May 13, 1899. Conditions of loading and ignition, of which no data are at hand at present, originated a wave action in place of the normal distribution of pressure. This surging of the gases moved forward along the axis of the bore with great velocity. Meeting the base of the moving projectile, it was reflected back and impinged upon the mushroom head, which would result in compressing the gaseous column, running up the pressure around the burning charge, and accelerating abnormally the rate of emission of gases. This action itself would tend to abnormal pressures, but especially upon the rapid movement of a considerable weight of powder gases being arrested by the breech, the dynamic movement was translated into an impulsive blow in an axial direction that exceeded the endurance of the breech system. In some features it bore a resemblance to a water hammer.

When the late Capt. Sidney E. Stuart was detailed by the Chief of Ordnance of the United States Army to take full charge of the development and manufacture of service powders, brown prismatic was in use and abnormal pressures were observed every now and then in proving the various lots. A few illustrations are given from the firing records:

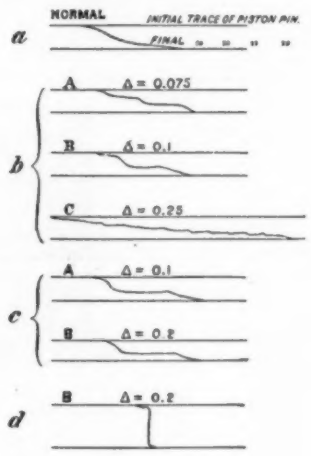
Gun.	Charge.	Velocity.	Pressure.	Remarks.
	Pounds	Foot Seconds	Pounds	
12 inch...	400	1932	36000	Normal
	406	2006	60000	
12 inch...	342	1724	33000	Normal
	350	1804	65000	
10 inch...	200	1813	37600	Normal
	200	1843	59000	

In the above firings the increase of velocities with increase of charge and variation of velocities with equal charges were those normal to single tests of brown powder. The changes in pressure were enormous. In the first group the pressure with 406 pounds should have been in the neighborhood of 37,000 pounds in place of the recorded 60,000 pounds, it being remembered that the gages are screwed into the mushroom head, and their axes are parallel to the axis of the bore. Neither an examination of the lot of powder from which the charges were taken nor an inspection of the factory records of the lot gave any facts to which the pressure variations could be pinned. M. Vieille, one of the group of French explosive engineers who have published in the Mémorial des Poudres et Saltpêtres some of the most valuable studies of explosives at our command, had investigated the action of powder gases in long closed tubes in connection with abnormalities found in French practice. He proved the existence of this wave action, and Capt. Stuart applied the theory to American practice with great success.

It will be well to examine this work of M. Vieille. The apparatus consisted of "a steel tube about 40 inches long and 2·4 inches in exterior diameter, the clear interior dimensions being about 35 inches and ⅞ inch respectively. The ends of this tube were threaded and received exactly similar crusher gages, the pistons of which carried pins external to the tube and projecting perpendicularly to it, designed to record the motions of the pistons. Ignition was obtained by an electric fuse carried by a screw plug entering from the side near one end. Obturation was secured by seating the plugs in copper rings. The tube was fastened in a horizontal fashion on a metallic table in the firmest manner possible. A strong axle placed near and parallel to the tube carried at each end a metal cylinder with a blackened surface, so placed as to receive the trace of the pen carried by the piston of the corresponding crusher gage. This axle was rotated by an electric motor by means of a pulley attached midway of its length, in order to avoid differences in the torsion of the axle between the pulley and the two cylinders. The scale of time was obtained by a tuning fork making 500 vibrations per second, which were sustained by an electro-magnet. Various refinements in the character and manner of this portion of the apparatus secured a rigorously exact scale of time, and the whole apparatus operated in a manner insuring a high degree of accuracy in its indications."

Three kinds of powder were used in the experiments, (*A*) musket, (*B*) siege gun, (*C*) large rifle. The conditions of loading were varied in three ways, the charge being distributed uniformly throughout the length of the tube, collected at one end, or collected similarly in equal parts at each end.

While the pressure was developing during an experiment, the piston of the crusher gage would move forward in reducing the height of the copper plug, and the pin carried by it would trace a curve upon the revolving cylinder, the tuning fork meanwhile establishing a time scale. As the weight of the piston was designedly light in accordance with the theory of crusher gages, the deformation of the copper plug would keep pace with the increase of pressures, and would register any momentary excess of pressure due to the compression of the head of a surging gaseous column, arrested at the end where the crusher gage was. M. Vieille put the rectified curves into four classes, typical case being illustrated in Fig. 1. Of these, *a* is the case in which the copper plug was compressed regularly to a normal value, *b* in which the deformation rose to a normal value by steps, *c* in which an abnormal deformation was produced by steps, and *d* in which an abnormal crushing was attained at once. Selecting illustrative data from the experiments, the following table shows plainly the value of uniform distribution of explosives in long tubes.



Powder.	Density of Loading.	Indicated Pressure, Pounds per Sq. Inch.	Class of Trace.	Conditions of Loading.
A	0·075	10,000	a	Uniform distribution.
	0·075	10,900	b	Collected at firing end.
	0·075	9,800 / 10,350	b	" " " "
	0·1	15,800	a	Uniform distribution.
	0·1	23,950	c	Collected at firing end.
	0·1	20,400	c	" " " "
	0·1	21,850	c	" " both ends.
	0·1	24,850	c	" " " "
	0·1	24,500 / 25,400	c	" " one end.
	0·2	34,500	a	Uniformly distributed.
	0·2	107,000	4	Collected at firing end.
B	0·2	29,500	a	Uniform distribution.
	0·2	66,600	d	Collected at firing end.
	0·2	51,300 / 49,300	c	" " " "
C	0·2	29,300 / 26,500	b	" " " "
	0·25	39,300 / 39,300	b	Results normal with uniform distribution in previous tests.

Double pressures mean readings from both gages.
Single readings from gage opposite firing end.

Previous experiments in much shorter éprouvettes (2 to 6 inches in length and 1 to 2·5 inches in diameter) had disclosed no difference in pressures with uniform and ununiform dispositions of explosives varying widely in their quickness. The tests in the long éprouvette revealed another state of affairs, as indicated in the above table. Up to a certain low limit of density of loading, increasing with the slowness of the powder, variations in the placing of the charge made little or no change in pressures. Above those limits the collecting of the charge at one end, or of equal parts at both ends, caused deformation of the copper plugs much in excess of that given by the case of uniform distribution at the same density of loading. This occurred with powders *A* and *B*. It would have taken place with *C* if the strength of the apparatus had permitted a higher density of loading. Referring to the pressure curves, all cases of uniform disposition were included in type *a*, showing that the pressure was developed regularly. Below the density of loading limit ununiform conditions gave curves of type *b*, in which the pressure rose to a normal value by successive steps. Above that limit ununiform distribution produced generally curves of type *c*, showing a development of abnormal pressure by several steps, and occasionally of type *a*, representing abnormal pressure in one step. A study of a large number of experiments of this nature led M. Vieille to the conclusion that "for densities of loading above the limiting values the crusher-gage coppers suffer excessive deformations, which demonstrate the existence of real excessive pressures, due to condensations resulting from the arrest at the ends of the chamber of the gaseous mass in rapid motion.

M. Vieille went further into the nature of this wave action, and experimented with the éprouvette suspended freely, and with crusher-gages whose pistons were too heavy to respond to the momentary pressures due to condensation at the end of the tube of the moving gaseous column. A careful review of the matter led him to formulate the opinion that wave action was possible in large rifles when certain conditions coincided. The influence of ununiform distribution of the charge above certain densities of loading depending upon the quickness of the powder has been noticed The universal practice in ordnance matters is to employ high densities of loading, much above these limits. The influence of length of powder chamber has been indicated by the difference in results obtained in short and long éprouvettes. This refers to the absolute length, and not to relative length in comparison with the diameter. The prevalent custom of igniting the charge is by means of a primer placed in the breech block, whose explosion, acting on the priming charge, would tend to set up some motion in an axial direction and contribute to pressure irregularity. This is borne out by some firings made in 1891 at Sandy Hook in two 3·2 field guns similar in all respects except that one had a radial vent for ignition of the charge, while the other had an axial vent. Loading conditions were the same, and black moulded powder used in these firings.

Charge.	Pressure.	
	Axial Vent.	Radial Vent.
3 pounds 5 ounces	26,080	32,500
3 " 6 "	37,000	32,450
3 " 7 "	41,300	33,000
3 " 7 "	38,400	31,000
3 " 8 "	39,500	34,350

It will be seen at once that axial ignition gave rise to higher and more irregular pressures than did radial ignition, confirmed by further tests with black and smokeless powders.

It would appear that wave action may find an origination in these conditions: Length of chamber, high density of loading, end ignition, quickness of powder, and ununiform distribution. The first three of these attend every firing of the large rifles of the day, and it may possibly be that the system of gaseous products of explosion is always on the verge of some degree of wave action that other causes may change, according to their nature, into mere irregularities or large and dangerous jumps in the pressure at the breech of the gun and extending more or less into the chamber.

Capt. Stuart noticed that abnormal pressures occurred with brown powder in the tests at Sandy Hook usually with reduced charges. Full charges were fixed to extend the length of the chamber, but smaller charges were generally reduced in length and not in diameter, providing thereby another favorable condition for wave action. Loading regulations were put into force then at Sandy Hook, designed to secure uniform distribution and regularity of inflammation of the charge. The Chief of Ordnance of the United States Army was able to report a year and a half later: "The occurrence of excessive wave pressure, frequently experienced in the earlier stages of our tests of brown powder, has been practically overcome."

Smokeless powders are at one disadvantage compared with brown prismatic. Any accidental variations in conditions that give rise to an abnormal pressure jump will carry it further with smokeless than with brown powder, for the rate of emission of gases increases more rapidly with the pressure in the former than in the latter. The relation in question is

$$V \propto P^x$$

in which V is the velocity of combustion of the powder at any pressure P, and x an exponential constant depending upon the powder used. M. Vieille has given these experimental values for x: Brown prismatic powder, 0·45; black powder, 0·55; smokeless powder of 50 per cent. military guncotton and 50 per cent. nitroglycerin, 0·55; smokeless powder of 50 per cent. soluble nitrocellulose and 50 per cent. nitroglycerin, 0·60; and smokeless powder entirely of military guncotton, 0·66. Furthermore, in a gun the action is a multiplying one. Some variation causes an irregular jump in the pressure; this increase makes the powder burn faster and deliver a large amount of gas. This additional increment of pressures increases still further the rate of emission, and so each reacts on the other until the movement of the projectile or the destruction of the gun relieves the pressure. This will indicate the complexity of the smokeless powder question. That article we must have. It involves the drawback just stated. On the other hand, a more uniform product is possible in commercial manufac-

ture. Then, again, in smokeless powders the introduction of nitroglycerin in quantity gives one with a lower rate of emission exponent, manufactured more rapidly and cheaply and having far higher ballistic properties than a guncotton powder. But nitroglycerin means a high degree of erosive action at least, while many contend that it introduces a dangerous mechanical stability into powders and generally lay any trouble with a nitroglycerin powder to its presence. It is indeed a puzzling matter.

To revert to the accident at Sandy Hook, it would seem reasonable that, if the inner jackets of the chamber show no signs of a general dangerous stress, wave action may be safely considered as the cause, coupled possibly with some weakness in the breech system of this particular rifle. If the chamber exhibits plainly that an excessive pressure existed throughout it, wave action must still have a prominent consideration, but the physical condition of this lot of powder enters into the case. Multiperforated powder can be badly made just as well as any other powder. Commercial methods may sometimes diverge from good practice. In 1897 the United States navy rejected 835,700 pounds of brown powder in getting 699,847 pounds of satisfactory powder. Badly warped and cracked multiperforated powder would not redound to the credit of the system through the results secured in firings. Shipments of cordite have been rejected on these grounds.

Let us examine multiperforated powder as regards uniformity and regularity, as these bear upon the starting of wave action. The general formula may be varied to produce powders running from a pure guncotton to a 60 per cent. nitroglycerin basis. In addition to the incorporation in the usual mixing machine, the ingredients are further mixed and kneaded thoroughly on rolls. From the press the powder issues in rods having exactly the cross section imposed by the forming die. Good practice in manufacturing insures that the shrinkage in drying is small and regular, this shrinkage occurring with all powders made with solvents. It is less in multiperforated powder than in other powders, and is distributed through at least three burning thicknesses in place of the one thickness of solid grains. The final dimensions of grains are completely in the control of the manufacturer, and accordingly all working details contribute to a maximum uniformity of powder. Matters still favor it in the gun. The gravimetric density of the grain is greater than with any other shape; that is, a given weight of multiperforated powder of any formula, with a given least dimension, will occupy more volume than the same weight made up into any solid grain with the same least dimension. Under these conditions more multiperforated powder can be used for a given pressure than is possible with the other powders. The natural result is that the chamber is more fully filled by the charge, and the danger of ununiform distribution through accident obviated to that degree. An essential point to regular pressures is regularity of inflammation of the powder by the priming charge. For this condition the multiperforated grain is ideal, since the perforations of the grain and the air spaces between the short cylinders afford an easy path for the igniting gases to penetrate and start simultaneous combustion throughout the entire charge. Laminal and cubical grains are sadly lacking in this respect, and their firing records testify to it. The mechanical integrity and structure of the grain rests here, as in other powders, with the personal equation of the factory. The company that developed the powder in question used the most trying formula, and yet every lot delivered gave a satisfactory account in guns, running from the 6-pounder rapid-fire gun to the 12-inch rifle, exciting comment by its remarkable uniformity and regularity of action. Another word in regard to the Hiram Maximized theory of internal explosion of the grains. Were it true nothing but solid rods are permissible. Yet nobody objected to brown powder with its central hole, or to short tubular smokeless powder. The short grains afford easy passage for the gases of internal combustion in their initial dimensions, and combustion increases the area of the passage as the square of the linear enlargement, while the burning surface is growing only in direct ratio. The best testimony of the erroneousness of the theory is given by some grains in the possession of Dr. R. C. Schüpphaus.

After a firing in the 3·2-inch field gun of a somewhat slow multiperforated powder, the pressure being 30,000 pounds, grains were found in the sand in front of the gun burned out perfectly, so that the circular perforations were almost tangent. Though quite fragile, they were perfectly intact. Another sample is an extra slow powder fired in an 8-inch rifle at 15,000 pounds pressure. It is burned up about half and in first-class condition. Again, after a firing in an 8-inch rifle at 35,000 pounds pressure, I picked up many of the curvilinear rods formed by the burning out of powder with circular perforations. Their heights were all uniform, and equal to the original heights less twice the burning thickness, as was to be expected from the combustion at both ends. I regret that the absence of Dr. Schüpphaus does not allow photographs of the grains mentioned, but the SCIENTIFIC AMERICAN ARMY SUPPLEMENT contains one of the grains partly burned at 5,000 pounds pressure.

Stretching down across the State of Iowa, commencing at the Minnesota line, lies a belt of counties which in the future may be rightly named the Egypt of Iowa, says The Rockford (Iowa) Register. The territory included in this belt is from 100 to 150 miles in width, and embraces what were known as the slough lands of the State in an early day—a region prolific in tall blue joint grass, frog ponds, small lakes, and possessing a black gumbo soil of unsurpassed fertility and durability. In the pioneer days men starved out in the effort to here grow a crop, the excess of moisture in the soil defeating their best efforts. Ditching, tilling, and cultivation have changed this condition, and today the world does not possess a more productive and fertile region. While the slopes and hills of the valley land bordering our great rivers already show marked evidences of exhaustion, this Egypt of the central black lands is coming to its own, and its marvelous productiveness is just beginning to be appreciated. As between the white farm on the hills and the black farm in the territory referred to, there is an immeasurable difference.

VALUABLE BOOKS.

MAGIC

Stage Illusions and Scientific Diversions, Including Trick Photography.

By ALBERT A. HOPKINS,

Editor of the "Scientific American Cyclopedia of Receipts, Notes and Queries," etc.

This unique work appeals to the professional and the amateur alike and will prove a welcome addition to any library. The illusions are illustrated by the highest class of engravings.

Great attention is paid to the exposés of large and important illusions; these have been in many cases furnished by the prestidigitateurs themselves. Some of the most important tricks of Robert Houdin, Bautier de Kolta, Heller, and Herrmann are explained. Conjuring is not neglected, a selection of some of the best known of these tricks having been made. Fire-eaters, sword-swallowers, ventriloquists, shadowgraphists, all come in for a share of attention, while the chapter on "Mental Magic" describes simple means of performing second-sight.

Such entertainments as cycloramas, fireworks, etc., are also treated, and all well illustrated with original engravings. Automata and curious toys are then described.

This work is acknowledged by the **Profession** to be

SECOND EDITION NOW READY.

THE STANDARD WORK ON MAGIC.

The section devoted to Photographic Diversions is very complete, giving the method of producing astonishing trick photographs. The method of taking and projecting moving photographs is described in detail—the vitascope, the cinematograph, the mutoscope, and the mutograph being fully described and illustrated. This work cannot fail to be of interest to young and old, and there is hardly any one who is in any way interested in either science or magic to whom it will not appeal. It is beautifully printed and is very attractively bound in special cloth, with stamp in colored inks.

568 Pages. 420 Illustrations.
Price, by mail to any part of the world, $2.50.
An Illustrated Circular sent on Application.

1898 EDITION.

EXPERIMENTAL SCIENCE.

By GEO. M. HOPKINS.

Twentieth Edition, Revised and Enlarged. 914 Pages. 820 Illustrations. Elegantly bound in Cloth. Price, by mail, postpaid, $4.00; Half Morocco, $5.00.

This is a book full of interest and value for teachers, students and others who desire to impart or obtain a practical knowledge of Physics.

This splendid work gives young and old something worthy of thought. It has influenced thousands of men in the choice of a career. It will give anyone, young or old, information that will enable him to comprehend the great improvements of the day. It furnishes suggestions for hours of instructive recreation.

What the Press says of "Experimental Science."

"Mr. Hopkins has rendered a valuable service to experimental physics."—*Evening Post.*

"The book is one of very practical character, and no one of a scientific turn of mind could fail to find in its pages a fund of valuable information."—*Electric Age.*

"The work bears the stamp of a writer who writes nothing but with certainty of action and result, and of a teacher who imparts scientific information in an attractive and fascinating manner."—*American Engineer.*

"It should be found in every library."—*English Mechanic.*

"The book would be a most judicious holiday gift."—*Engineering and Mining Journal.*

Mr. Thomas A. Edison says: "The practical character of the physical apparatus, the clearness of the descriptive matter, and its entire freedom from mathematics, give the work a value in my mind superior to any other work on elementary physics of which I am aware."

Prof. D. W. Hering, University of the City of New York, says: "I know of no work that is at the same time so popular in style and so scientific in character."

Prof. W. J. Rolfe, of Cambridgeport, Mass., writes: "The book is by far the best thing of the kind I have seen, and I can commend it most cordially and emphatically."

Hundreds of cordial recommendations from eminent Professors and Scientific men.

Send for Illustrated Circular and Table of Contents.

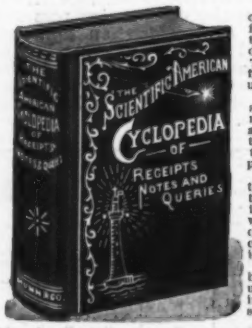
THE SCIENTIFIC AMERICAN

CYCLOPEDIA of RECEIPTS, NOTES and QUERIES

EDITED BY ALBERT A. HOPKINS.

12,500 Receipts, 708 Pages.

Price, $5 in cloth; $6 in sheep; $6.50 in half morocco; Postpaid



This splendid work contains a careful compilation of the most useful Receipts and Replies given in the Notes and Queries of correspondents as published in the SCIENTIFIC AMERICAN during the past fifty years; together with many valuable and important additions.

Over twelve thousand selected receipts are here collected; nearly every branch of the useful arts being represented. It is by far the most comprehensive volume of the kind ever placed before the public.

The work may be regarded as the product of the studies and practical experience of the ablest chemists and workers in all parts of the world; the information given being of the highest value, arranged and condensed in concise form, convenient for ready use.

Almost every inquiry that can be thought of, relating to formulæ used in the various manufacturing industries, will here be found answered.

Those who are in search of independent business or employment, relating to the home manufacture of salable articles, will find in it hundreds of most excellent suggestions.

A COMPLETE

ELECTRICAL LIBRARY

By Prof. T. O'CONOR SLOANE.

Comprising five books, as follows:

Arithmetic of Electricity, 138 pages	**$1.00**
Electric Toy Making, 140 pages	**1.00**
How to Become a Successful Electrician, 189 pp.	**1.00**
Standard Electrical Dictionary, 682 pages	**3.00**
Electricity Simplified, 158 pages	**1.00**

☞The above five books by Prof. Sloane may be purchased singly at the published prices, or the set complete, put up in a neat folding box, will be furnished to Scientific American readers at the special reduced price of **Five dollars.** You save $2 by ordering the complete set. **Five volumes, 1,300 pages, and over 450 illustrations.**

☞Send for full table of contents of each of the books.

☞Our complete book catalogue of 116 pages, containing reference to works of a scientific and technical character, will be sent free to any address on application.

MUNN & CO., Publishers, 361 Broadway, N. Y.

THE

Scientific American Supplement.

PUBLISHED WEEKLY.

Terms of Subscription, $5 a Year.

Sent by mail, postage prepaid, to subscribers in any part of the United States or Canada. Six dollars a year, sent, prepaid, to any foreign country.

All the back numbers of THE SUPPLEMENT, from the commencement, January 1, 1876, can be had. Price, 10 cents each.

All the back volumes of THE SUPPLEMENT can likewise be supplied. Two volumes are issued yearly. Price of each volume, $2.50 stitched in paper, or $3.00 bound in stiff covers.

COMBINED RATES.—One copy of SCIENTIFIC AMERICAN and one copy of SCIENTIFIC AMERICAN SUPPLEMENT, one year, postpaid, $7.00.

A liberal discount to booksellers, news agents, and canvassers.

MUNN & CO., Publishers, 361 Broadway, New York.

TABLE OF CONTENTS.

	PAGE
I. AGRICULTURE.—Cultivation of the Vanilla Bean in Mexico	19580
II. ARCHÆOLOGY.—Engraved Shells	19580
The Palatine Hill of Rome.—7 illustrations	19574
Wilson's Prehistoric Art.—II.—The Neolithic Period.—9 illustrations	19577
III. AUTOMOBILES.—Electric Hacks at Paris.—4 illustrations	19570
IV. CHEMISTRY.—Carbon Vapor in the Sun	19580
V. CIVIL ENGINEERING.—The Damming of the Nile	19572
VI. COMMERCE.—Exports of American Furniture	19577
Trade Suggestions from United States Consuls	19582
VII. ELECTRICITY.—Cloth Pressing by Electricity	19571
VIII. FUELS.—Our Coal Supplies.—By T. FORSTER BROWN	19566
IX. MISCELLANEOUS:	
Engineering Notes	19573
Electrical Notes	19573
Selected Formulæ	19573
X. NATURAL HISTORY.—The Love Gifts of Birds	19579
XI. NAVAL ENGINEERING.—The New German First-class Battleship "Kaiser Friedrich III."—3 illustrations	19567
XII. ORDNANCE.—Wave Action in Guns.—By FREDERICK H. MCGAHIE.—1 illustration	19581
XIII. PSYCHOLOGY.—Does Thinking of a Part Affect its Growth	19569

= = = SPECIAL = = =

Bicycle and Automobile

ISSUE OF THE

SCIENTIFIC AMERICAN

Special efforts have been made to render this issue of the SCIENTIFIC AMERICAN, dated May 13, thoroughly popular and attractive. It is enlarged to 32 pages and inclosed in a very handsome cover printed in several colors.

It opens with very readable articles on the general subject of the Bicycle and the Automobile. It is not generally known that the automobile is older than the locomotive; but in this special number one form of the horseless carriage that was in use early in this century is illustrated and described, together with detailed drawings showing the De Dion-Bouton Automobile Tricycle.

This issue contains illustrated articles on the leading types of automobiles, and detailed drawings are given of one of the most successful of the French motors. The mechanics of the bicycle are treated in an illustrated article in which the simpler tricks of bicycle riding are explained.

This number is thoroughly readable and of unusual interest to all who are in any way interested in out-door sports.

A Beautiful Special Number—Profusely Illustrated—32 pages—Cover in Colors.

For sale at all news-stands. Price 10 cents.

MUNN & CO., Publishers,
361 Broadway, - - - New York City.

BUILDING EDITION

OF THE

SCIENTIFIC AMERICAN.

Those who contemplate building should not fail to subscribe.

ONLY $2.50 A YEAR.

Semi-annual bound volumes $2.00 each, yearly bound volumes $3.50 each, prepaid by mail.

Each number contains elevations and plans of a variety of country houses; also a handsome

COLORED PLATE.

SINGLE COPIES, - - - - 25 CENTS EACH.

MUNN & CO., 361 Broadway, New York

PATENTS!

MESSRS. MUNN & CO., in connection with the publication of the SCIENTIFIC AMERICAN, continue to examine improvements, and to act as Solicitors of Patents for inventors.

In this line of business they have had *over fifty years' experience*, and now have *unequaled facilities* for the preparation of Patent Drawings, Specifications, and the prosecution of Applications for Patents in the United States, Canada, and Foreign Countries. Messrs. Munn & Co. also attend to the preparation of Caveats, Copyrights for Books, Trade Marks, Reissues, Assignments, and Reports on Infringements of Patents. All business intrusted to them is done with special care and promptness, on very reasonable terms.

A pamphlet sent *free of charge*, on application containing full information about Patents and how to procure them; directions concerning Trade Marks, Copyrights, Designs, Patents, Appeals, Reissues, Infringements, Assignments, Rejected Cases, Hints on the Sale of Patents, etc.

We also send, *free of charge*, a Synopsis of Foreign Patent Laws, showing the cost and method of securing patents in all the principal countries of the world.

MUNN & CO., Solicitors of Patents,
361 Broadway, New York

BRANCH OFFICES.—No. 625 F Street, Washington, D. C.

899.

ent.

in any
dollars a

rom the
Price,

an like-
yearly.
or $4.

AMERI-
SUPPLE-

nts, and

York.

PAGE
..... 19680
..... 19681
illus- 19687
..... 19689
..... 19690
..... 19692
..... 19697
..... 19698
..... 19699
..... 19702
..... 19703
..... 19710
..... 19711
..... 19712
..... 19713
..... 19714
..... 19715
..... 19716
..... 19717
..... 19718
..... 19719
..... 19720
..... 19721
..... 19722
..... 19723
..... 19724
..... 19725
..... 19726
..... 19727
..... 19728
..... 19729
.....